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IN ALL THEIR DEPARTMENTS.

ARTESIAN WELLS, AND THE PHENOMENA OF SPRINGS.

When a boring of small diameter, as from 4 to 18 or 20 inches, is made from the surface of the earth down to strata which yield a supply of water, and when the water either rises through the whole length of the boring, and spouts up as a fountain above the surface, or when it rises only part of the height up to the surface, the term Artesian well, or Artesian fountain, is applied to this method of procuring water. Sometimes, also, an open well of 5, 6, or more feet in diameter is sunk down for some distance, and continued by boring till the required supply of water is obtained; if this water then rises through the boring, and maintains a permanent level, either at or near the bottom of the open well, the work is now commonly called Artesian, although it is thus considerably different from the spouting or flowing wells of the province of Artois in France (the ancient Artesium), from which their name is derived.

The generally received theory respecting the rise of water in this kind of well, refers the phenomenon to the action of an inverted syphon, one of whose branches is of natural origin beneath the surface of the earth, while the other is that which is artificially bored to meet the presumed natural reservoir. The rise of water in Artesian wells bored in the basin of London, has been simply explained by Dr. Buckland, and illustrated by a theoretical section of the strata composing the basin. This section shows that the water is received into a chain or zone of porous strata, which encircle the solid impermeable clay of which the centre consists,—that the elevation of this zone is considerably higher than the surface of the basin throughout many square miles of its extent, and that therefore borings which penetrate through the clay will permit the rise of the water, which, under these circumstances, will pass upwards with the force due to the hydrostatic pressure which they occasion. This theory has been generally adopted by most British geologists; and practical men—engineers and others—have followed up with the same opinion whenever the projects they are engaged in present a necessity for arguing upon theoretical grounds. Thus Mr. Robert Stephenson, the able and experienced engineer of the London and Birmingham Railway, in advocating the project for supplying the metropolis with water by boring into the chalk at Watford, has availed himself of Dr. Buckland's views, and adopted the same theoretical section, illustrating the structural arrangement of the London basin, as that which Dr. Buckland himself used.

If we suppose, in accordance with the prevailing opinion, that most of the porous strata, where they crop out or occupy the surface of a country, receive the water which falls upon them in the form of rain and snow, and convey this water to subterranean reservoirs far below the surface, we shall be prepared to entertain the idea of numerous vases constructed of porous materials, each placed within the other, but separated from contact with it by the interposition of some impermeable substance. All assemblages of rocks appear to be arranged in the form of basins, of which the edges are more or less entire; and even where we find a succession of strata resting upon each other, and exhibiting the simple structural arrangement of numerous planes, dipping in uniform directions, we are justified by the evidence of analogy and comparison in considering these as so many fragments and broken masses of concentric vases, which once reposed entire, one within the other. At this day we find the strata of some of the coal fields reposing in entire troughs or basins of mountain limestone; and, in a similar manner, the tertiary strata in many parts of Europe are disposed in concentric layers in a hollow or cavity of the chalk, the edges of this circumscribing formation being in some cases nearly entire, and in other cases remarkably broken through by rivers, gulfs, and estuaries. The geological structure of our own country, particularly that of the strata from the most recent tertiary formation, down to the great mass of clays and sandstones below the green sand, remarkably illustrates this basin-shaped arrangement, because we find the very same chalk in Hertfordshire, Cambridge, and Norfolk, as that which composes the remarkable chain called the Surrey Downs, and we also find the very same strata of fire-stone, gault, and sand, dipping every where in the same order under the chalk. Hence, there is no room for doubting that the whole of these strata are continuous, each in regular order, under the one beneath which it crops out on the surface. Now, as it would carry us too far beyond the object we have in view at present, to go into any general examination of geological structure, as relating to the subject of Artesian wells, we shall confine ourselves to the form of basin which has hitherto been distinguished as the peculiar region of this kind of well, namely, the tertiary formations of London and Paris, with the secondary strata on which they rest. In each of these districts, we find successive strata of sands and clays alternating with each other, and separated by the immense intervening formation of the chalk, the whole arranged in that dish or basin-shaped form, which has been already alluded to. Now, in each of these basins, any one of the porous strata may be considered as a vase constructed of a porous material, and if we represent one of the continuous seams by a porous vase, and conceive it to be lined inside with clay, and then another vase to be placed upon the clay, and this again to be succeeded by another layer of clay, and so on, we shall have a correct idea of the arrangement which prevails in the whole series of the strata under consideration. Thus, for instance, in the London basin, the uppermost term of the series is the sand of Bagshot and Hampstead heaths, below which succeed the yellow and blue clay, so generally known under the name of London clay. Next below this, are the sands of the plastic clay formation, usually separated from the chalk by the peculiar yellow clay so valuable as a brick earth. The chalk itself consists of beds which are mostly permeable by water, although this is by no means its invariable character, as strata of fuller's earth, of marl, and of very compact chalk, capable of damming up water, not unfrequently occur in it, principally in the upper part of the formation. The fire-stone, in its

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capacity for saturation by water, scarcely differs from the lower beds of the chalk; but below the fire-stone comes a remarkably stiff clay, termed the gault, which acts as a complete dam for the water contained in the fire-stone and the lower part of the chalk formation.

This disposition of masses, which are alternately porous and impervious to water, leads to the idea of successive stages, which are traversed by water, in which reservoirs of water exist, and from which the water may be expected to rise in borings which penetrate them. Thus, in the London basin, the sands of Hampstead Heath, and those of Bagshot, Frimley, and Woking, may be considered as the uppermost reservoirs of the basin, and, accordingly, we find, that wherever these are overlaid by patches of clay, and particularly wherever, in depressions or vallies of the sand, the clay runs up in the form of a tongue from the general mass on which the sand rests, there a line of springs may be traced, giving rise to streams, which take their course over the clay district. Now, as the water with which these sands are saturated has a natural outlet afforded to it in this way at the line of its junction with overlying patches of clay, it will be inconsistent to suppose that, in wells sunk into the sand, the water will stand at a higher level than this, its natural line of escape. It may, however, occasionally be found at higher levels than that which appears to be its natural drainage, but this anomaly will only present itself when we are unable to detect the impediments by which the structure of the hill opposes the free passage of the water, and dams it up in the interior at higher levels than that by which we see it escape on the declivities. In fact, it is only by admitting that great irregularity prevails in the flow of water through even the most porous strata, that we are able at all to reconcile many anomalous facts connected with its rise in wells which are placed often in the immediate neighbourhood of each ot er, and in which the water is often found at a variety of different levels, instead of being at the same in all. We must, also, enlist the same supposition of irregular opposition to its flow, and of different degrees of porosity in the strata, in order to account for the water being thrown out by a narrow tongue or neck of clay running up the centre of a gorge, and still more so to account for this effect when produced by an entirely isolated patch or outlier of clay. Arguing theoretically on either of these cases, it would be said, that as a great mass of porous material lies below the extremity of these tongues or outliers, and as the general border of the clay on which the sand reposes is far below this level, the water would sink down to the very bottom of the formation, and would only be thrown out at the line of junction with the great mass of clay.

Fig. 1., (*see the plate*) which is a vertical projection of a hill, under the circumstances of Hampstead Heath, will serve to illustrate these remarks. A and B are outliers and tongues of clay, which occasion small springs around their edges where they come in contact with the sand, and in wells sunk in their neighbourhood water will rise to the level of the dotted lines drawn horizontally across their vertical extremities. Notwithstanding the water which is intercepted and thrown out by these wholly or partially insulated masses of clay, the main line of springs will be around the general edge of the basin at *a*, and these will be copious in proportion as that edge is depressed. The well at *b* shows the depth at which it will be necessary to bore through the sand, in order to reach the main line of springs at the level of *a b*; above which level the water cannot, on theoretical grounds, be expected to rise any where in the neighbourhood.

Below the sands of this formation the great mass of yellow and blue clay which succeeds, is almost destitute of water, because the very thin partings or seams of sand which occur in it, permit only a very small quantity to percolate through it. It is true, that in many parts of the district occupied by the London clay, there are wells sunk from the depth of twenty to thirty feet, and these furnish to the metropolis a vast supply of water. But it is a great mistake to suppose that these wells penetrate the real London clay. They pass, in fact, merely through the loose diluvium which covers it, and this diluvium, consisting like more perfect formations of alternate beds of clayey and sandy materials, contains an abundance of springs caused by the infiltration of water through the various pot-holes, patches, and beds of sand which are copiously mixed up with the clay. The water of these wells is notoriously hard, and of bad quality; a fact which can scarcely occasion surprise, when we reflect that it proceeds from the drainage of a district whose surface, and whose atmosphere, are loaded with all kinds of impurities, and that it does not pass through a sufficient extent of mineral strata to enter into any combination with any mineral salts, or to receive the benefit of either chemical or mechanical purification.

It follows, therefore, that whenever the supply of water is required to be of good quality, as for public establishments, and for certain chemical and manufacturing purposes, the wells must penetrate through the London clay, down to the sands of the plastic clay, which are interposed between the chalk and the blue clay of this formation. The sands of the plastic clay, then, constitute the second grand reservoir in the basin of London. They are, also, the first Artesian stage, that is the first in which water will rise in bores above, or nearly up to, the surface of the ground; because, in wells, or borings, made through the Bagshot sand, the water, as we have seen, will not rise above the level of the clay by which it is dammed up, and of course the surface of any boring where water will rise at all, must always be above the dam which causes it to be met with at that place. But the sands of the plastic clay are in a different position, for they pass entirely under an immense mass of impermeable clay, and therefore occupy the position of a true porous vase, imbedded in a basin of chalk. The plastic clay occupies a considerable breadth of country, as will be seen by the following statement, in which the breadths are taken across the range of the formation, and as nearly as possible at right angles to its direction: thus, from Hertford to Waltham Abbey, it is 7½ miles in breadth; from Hatfield to Southgate, 11½ miles; from Stanmore to Hemel Hempstead, 13 miles; of this, however, there is an interval of two miles, occupied by the chalk in the valley of the Coln, so that the clay of Hemel Hempstead is an outlier, isolated from the general mass of the formation. Again, from Great Berkhampstead to Weald Park, is 15 miles and a half, with an interval of 3 miles, occupied by the chalk. Beyond this place the clays and sands extend in several narrow slips far over the chalk, and a considerable breadth of the formation even passes into Wiltshire, a distance of nearly 50 miles from its eastern limits about Brentford and Ealing. In a direction north and south, from Great Berkhampstead to Guildford, the plastic clay is 36 miles in breadth, from which must be deducted 13 miles of surface occupied by the Bagshot sands, the London clay, and the chalk, having 23 miles, throughout which the plastic clays are actually at the surface. This is, probably, the greatest clear breadth of the plastic clay, and that already stated, from Hungerford, in Wiltshire, to Brentford, is probably its greatest length from east to west.

East of Guildford the plastic clays and sands occupy almost the entire space between the Thames and the chain of the North Downs, extending from Ewell, in Surrey, to Shoreham, in Kent, with an average breadth of about 11 miles. The clay is here denuded in the valley of the Dart, and, beyond this interruption, it becomes of inconsiderable extent in Eastern Kent.

Now, although the whole of this great extent is not entirely composed of sands, but, on the contrary, of sandy and clay beds in alternate order, it must yet be obvious that the quantity of water absorbed by so vast a surface must be very considerable, and, accordingly, we find that Artesian and other wells, sunk either on the surface of the plastic clay, or through the London clay, down to the inferior sands, are abundantly supplied with water. The separate strata of sand in the plastic clay, with their intermediate beds of clay, afford a variety of levels from which water is obtained, and owing to the irregularity of these beds the present state of our knowledge does not enable us to distinguish the different levels of these water-bearing beds. We are therefore under the necessity of considering the whole mass of the plastic clay as a tolerably porous vase, holding in its centre a thick mass of impervious matter, known by the name of the London clay. Where the sands of the plastic clay are in immediate contact with the chalk, as about Croydon, it is obvious that a porous stratum like the chalk will be much saturated with the water draining through the sands, which, under these circumstances, will be comparatively dry, and hence we find that numerous wells in the metropolis, which are supposed to derive their supply from subterranean lakes flowing from the south, are made to yield an increased supply by sinking a few feet lower in the chalk. Indeed, it is probable that many complaints of injury inflicted on the owners of one well by the too close contiguity of another, would be entirely obviated by sinking either of these a few feet lower than the other, by which means a new supply would be obtained from an independent source. On the other hand, where the plastic clay, properly so called, reposes in immediate contact with the chalk, we can scarcely suppose that the water from the sands will sink through the water-tight covering which thus separates them from the chalk. But even in this case it will often be found that the chalk is completely saturated with water, on account of the supply which it has itself received where it appeared at the surface. It is generally believed that the chalk has been the theatre of at least one violent subterranean convulsion, which has thrown up and greatly shattered most of its lower beds. This, and other hypotheses which have been advanced, are sufficient to account for the cracks and fissures with which the chalk is every where filled. In consequence of these, combined with the porosity of the actual matter of chalk, we commonly find the whole formation saturated with water wherever the circumstances are favourable for retaining, or, in other words, where the natural means of draining it are imperfect.

Considerable difference of opinion is entertained by Mr. Stephenson and Mr. Webster, the eminent geologist, to whose researches we are much indebted for an acquaintance with the strata above the chalk. Mr. Webster insists that the sands of the plastic clay form the great waterbearing strata from which the water of the London wells is derived, whereas Mr. Stephenson is of opinion that the chalk itself is the great waterbearing stratum, and that the sands of the plastic clay are only a subordinate member of that which may be so called. For our own part, we can see no possible reason for disputing on a point like this; every one knows that the sands yield water very copiously, and also that when the boring is continued into the chalk the supply is greatly increased. For instance, in the well recently sunk at Messrs. Truman and Hanbury's brewery, in Spitalfields, it was found that the sands yielded 48 gallons of water per minute, and the chalk, which was bored into 200 feet, yielded a further supply of 33 gallons per minute.

All the Artesian wells which have hitherto been sunk in the London basin have either derived their supplies from the sands, or from borings made to a comparatively trifling depth in the chalk. It is probable, however, that the principal reservoirs of the chalk lie deeper than the levels which have hitherto been reached in this way. The proposal made by Mr. Stephenson to procure a supply of 800,000,000 gallons per day by sinking and driving headings in the chalk at Watford, is undoubtedly a magnificent project, and to those accustomed to underground operations, and particularly to those who are aware of the enormous quantity of water discharged by pumping from some of the Cornish mines, it will not appear so visionary as some have affected to believe it. We heartily wish every success to Mr. Stephenson's project, and we hope before many years to see in operation one of a still more extensive nature, namely, a grand shaft, sunk in some part of the metropolis, entirely through the London clay, the plastic clay, the chalk, and the gault, down to the sands of the green sand formation. These sands it may well be said constitue a reservoir capable of supplying an almost unlimited quantity of water, since they are nowhere drained or cut through, except at very high levels; and as the naked sand throughout the whole range is exposed at the very surface, every drop of water which falls on them sinks into the earth, and follows a subterranean channel to the lower levels of the formation. The water in these sands is held up by the clays of the Wealden and the oolite, and if once they could be reached by boring in the basin of London, the supply would be equal to any thing that could be required for the consumption of the whole metropolis.

We present our readers this month with a section of the Artesian well at Grenelle, a work which does infinite credit to the skill, sagacity, and enterprize of the talented engineer who projected it. This well penetrates through the entire thickness of the chalk down to the sand which we have spoken of; and amply has the vast labour bestowed on it been rewarded. (For some account of this well see the Journal, page 248.) Some of the French papers have been lately predicting that the project, however, will after all prove a failure, in consequence of the impurity of the water, which continues to come up mixed with sand, and in a state quite unfit for use. This difficulty, however, is by no means so formidable as the alarmists affect to represent, for it is easy to construct in some part of the boring a filtering apparatus, through which the natural impetus of the water will be amply sufficient to cause it to ascend, and by this means it will reach the surface in a pure condition, and still spout, as at present, many feet above it.

The principal Artesian wells at present existing in this country are those called Blow Wells, on the coast of Lincolnshire, where the water rises in a fountain above the surface; those in the valley of the Thames, about Brentford and Fulham; and that sunk at Sheerness for the use of the dock-yard. In all of these the water rises above the surface; and in addition there are many in other parts of London in which the water rises nearly to the surface. The well at Messrs. Truman's brewery is one which has been recently sunk; and there is also one at the New Prison, Pentonville, and one in Piccadilly, executed, we believe, by the parish of

St. George's, Hanover Square. None of these wells penetrates far into the chalk, and therefore they do not meet with the main supplies which this great mass of porous rock contains. However, the water obtained from the plastic sands, and from the upper beds of the chalk, is infinitely superior to the vile trash doled out by the water companies, who have for the most part grossly abused the privileges with which Parliament has entrusted them. It is decidedly a flourishing and wholesome sign of the times to observe the parochial authorities of at least one great parish in the metropolis shaking off the insolent yoke by which every consumer of this prime article of necessity has been too long oppressed.

We are informed that an Artesian well is either in progress, or is about to be immediately undertaken, by the spirited vestry of this parish, for the supply of water to their workhouse; and we have heard of several individuals who have devoted the valuable aid, not only of their time and talents, but of their private purses, to secure for their fellow parishioners freedom from that infamous thraldom, which compels them to be half poisoned at the will and pleasure of an arbitrary and irresponsible water company.

LITHOLOGY, OR OBSERVATIONS ON STONE FOR BUILDING, BY C. H. SMITH.

(FROM THE TRANSACTIONS OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS.)

(*Continued from page* 264.)

PART II. TREATING CHIEFLY OF THE OOLITES.

FEW branches of physical science present a more extensive field for the imagination to range in, or a more complete series of well-established facts, than that which relates to calcareous substances. Limestone is one of the most abundant materials in the creation. Geologists have esteemed it as occupying, probably, one-eighth of the external crust of the globe, and it appears distributed throughout the world proportionably to its general utility in the animal economy.

From the chemical resemblance of all limestones and marble to the material constituting fish, shells, and corals in general; from the well-known rapid accumulation of the latter, and from the prodigious beds and districts of the remains of crustaceous animals uniformly occurring in the contexture of many varieties of stone, it has with good reason been conjectured that marble, limestone, and all other indurated calcareous rocks derive their origin from the animated productions of the waters, ultimately diversified by local circumstances, and differently modified by combinations with which we are at present but little acquainted. To an architect it is a question of little importance whence, or under what conditions, the limestones originated. To a contemplative mind such an investigation must produce the most sublime reflections on Almighty power; but such notions must now be dismissed, in order to consider not what limestone has been, but what is its present state, and what its condition is likely to be if exposed to the weather for a few centuries. The general term "limestone" must be understood to include many varieties, such as those which are composed almost entirely of shells, others named oolites, magnesian limestones, and several of excellent quality that form a sort of connecting link between those of a more definite kind. The purest and most compact limestone may be defined as a transparent, colourless, solid substance. Iceland or double refracting spar is probably the purest carbonate of lime; white marble is also extremely pure, the separate crystals of which are nearly transparent; but the limestone generally used for masonry is more porous, frequently quite opaque, and specimens may be found of many different colours. On examining the internal structure of calcareous rocks, they will be found to be adorned with patterns of variegated hues and forms. Shells may be observed in one, veins in another, corals and encrinital cylinders in others, and some in which no particular figure can be discovered; and, notwithstanding they differ so much in appearance, yet the very materials that nature applied to form such apparently opposite creations are almost identical; the whitest chalk, and the blackest marble,—the softest Bath stone, and the hardest Purbeck, are all formed of very nearly the same materials, scarcely differing except in the manner in which they are developed, or in the nature and extent of their duration. If a fine-grained limestone has so considerable a degree of hardness that it will take a good polish, it receives the pompous name of "marble," although it may possess no chemical qualities but such as are common to all the calcareous earths. The extremely fine-grained kinds of limestone often contain in their composition argillaceous earth, which renders them unfit for external work, especially if the proportional amount is great. Totternhoe stone, from the environs of Dunstable, is the softest and finest-grained stone I have ever seen used for architectural works: all those richly carved altar screens, shrines, and chapels, in St. Alban's Abbey, are made of this material. It contains at least 30 per cent. of clay in its composition, and has failed in many instances where it has been exposed to the weather, even where it has been used for ashlar, protected with a more durable stone for cornices and dressings. A newly fractured dry specimen gives out a peculiar earthy odour immediately after being breathed upon; but a more certain method of detecting the clay is to dissolve some fragments in diluted muriatic acid, which will hold the lime in solution, leaving the clay at the bottom of the vessel. If this be washed to get rid of the acid, it may be collected, dried, and after being made red hot in a common fire, it will become precisely like a piece of brick or tile.

Some of the shelly varieties of limestone are extremely durable, although of too coarse a texture for small ornaments. The formation appears to have been a vast quantity of shells, rarely exceeding two or three species, most of them broken or pulverised, and apparently water-worn. In process of time the mass became indurated, and cemented together with carbonate of lime from the decomposed shells; in this state, when applied to architectural works, the shells which have remained unbroken, and the largest fragments, seem to exercise a sort of protective influence over the exposed surface of the stone. If the softer parts of a shelly stone have decomposed in the first 100 years so much as to leave the shells projecting from the general surface to the extent perhaps of one-eighth of an inch, we must not calculate that decay will continue progressively at the same rate, for the numerous projections prevent mechanical violence, and preserve the more fragile part of the stone in a variety of ways; so that probably in the second 100 years decomposition will not be more than one-sixteenth of an inch, and less and less every year. The best kinds of shelly limestone are from Barnach, near Stamford; Taynton, near Burford; Ham Hill, near Yeovil; Weldon in the Wood, Northamptonshire; and Grove Quarries at Portland. All these are

only varieties of the oolitic rocks; in most of them the ova may be distinctly observed in the spaces between the shells.

The oolitic rocks traverse England from the extremity of Yorkshire to the coast of Dorsetshire, in many places affording prodigious quantities of excellent stone for building; but variations of structure, hardness, and durability, are found in different quarries, tending to show the changeable nature of the subdivisions, even in short distances, throughout the entire district, which extends nearly 300 miles. At an early period it is but reasonable to suppose that the ova or oolitic grains were loosely deposited in prodigious heaps at distinct and distant periods of time, which will account for the several beds or strata. It is with the oolites as with other stones, that the goodness or power to resist decomposition depends chiefly upon the quantity and quality of the cementing substance by which the particles adhere to each other. The cement which makes the globules into a mass is formed of the same elements as the globules themselves, but more crystalline; it is in fact the decomposition of some of the super-incumbent mass, saturating and crystalizing throughout the beds beneath. As the cement is of primary importance to the duration of a stone, I think it advisable to give a short account of its formation or physical properties. Water, even in its simplest state, may be considered to act as a solvent to most things; but when it contains acids, its power of dissolving calcareous substances is considerably augmented. Many waters are impregnated with carbonic acid, obtained partly from the atmosphere, and frequently from subterranean sources. If they contain a superabundance of carbonic acid, they will rapidly decompose limestone, and carry the atoms thus sustained in solution until a certain quantity of the acid in a gaseous state has evaporated, when the atoms of limestone will again solidify in crystals, and perhaps assume a totally different character. If this ingenious process of nature be carried on for a great length of time, over a considerable thickness of loose calcareous matter, the probability is, that the water, thus charged with lime and carbonic acid, will saturate the more porous parts, and thus ultimately form a well-cemented and compact limestone of what was originally a congeries of loose ova or grains. Where these waters trickle through a vaulted roof, and pervade the walls of those natural caverns in which limestone strata abound, they stud the sides with an infinity of brilliant crystalline deposits, or produce pendant stalactites, that hang from the ceiling in a thousand fantastic forms.

Carbonic acid is probably generated by nature more abundantly in Italy than in any other country. Most of the waters which flow from the Apennines are highly impregnated with it, owing most likely to the subterranean fire acting upon the calcareous rocks of which the Apennines are composed. Such waters charged with carbonic acid will, as already described, under different circumstances, at one time dissolve and afterwards deposit calcareous matter. In Italy these aqueous depositions have already produced enormous quantities of durable building stone, known by the various names of Travertine, Marmor Tibertinum, Calcareous Tufa, &c. Some of the Italian lakes and streams are so completely saturated with the materials which form limestone, that if a stick be thrown in, a few hours is sufficient to give it an incrustration of this substance. Sir Humphry Davy, in describing the Lacus Albula, or Lake of the Solfatara, which discharges itself into the Anio or Teverone, below Tivoli, says, "In May, 18—, I fixed a stick on a mass of travertine covered by the water, and I examined it in the beginning of the April following for the purpose of determining the nature of the depositions. The water was lower at this time, yet I had some difficulty, by means of a sharp-pointed hammer, in breaking the mass which adhered to the bottom of the stick: it was several inches in thickness." The county of Derbyshire furnishes instructive and interesting illustrations of all such peculiarities in the action of carbonated water upon limestone, and the well-known "petrifying spring" at Matlock, presents an excellent example; but such aqueous depositions almost always occur where carbonic acid and lime are present. Even the stony concrescence, usually denominated "fur," which is often secreted upon human teeth, and which is occasioned by lime taken in the water or food meeting with carbonic acid expired from the lungs, is in every respect the same as the travertine, with which the Cyclopean walls and the gigantic temples at Pæstum, and in Sicily, are built. In all cases crystallization is materially assisted by having some solid body for a nucleus, especially if that nucleus be of the same mineralogical character as the solution to be crystallized. Thus it is that the oolitic ova all contain a central speck, sometimes of limestone, very frequently a minute fragment of shell, from which needle-shaped crystals commence. By a chemical analysis of different specimens of oolite, selected from quarries at a considerable distance from each other, we learn not only that they are all composed of nearly the same elements, but also that the proportional quantities of the elementary substances which form the aggregate of each stone do not materially vary in any of them. The mechanical arrangement of the atoms which form the ova and the cement must, therefore, be examined, to find out the cause of so much difference of durability, and the influence of weather, which is known by experience to exist among the oolites.

In some stones the ova are so extremely soft, as to resemble minute balls of chalk. If these are united with an abundance of well-crystallized cement, the stone will in all probability be a durable one, although the ova near the surface will soon be washed out, leaving an extremely cellular structure, somewhat resembling fine sponge. Stone from the Taynton quarries, near Burford, to which I alluded in my former paper as having been used in the most exposed parts of the buildings at Oxford, is a good example of a material of this description.

The stone from the Ketton quarries in Rutlandshire is a remarkably well-developed oolite. The ova of the lowest bed, which is the only bed used for architectural works, have scarcely sufficient cement to hold them together: nevertheless, that small quantity is of the best quality; and although this stone is by no means among the most durable, it resists disintegration much better than might be expected from its appearance, which presents a remarkably open and porous texture.

Many quarries of oolite contain upper beds considerably harder than those which lie beneath, arising from the ova being very hard, and the interstices being completely filled with a compact, highly crystalline cement. Stone of this description is generally very durable, but frequently unfit for general purposes, because its hardness renders the labour of working it into ornamental architecture rather expensive. The stratum immediately above the lowest bed, or "freestone," in the Ketton quarries, called by the quarrymen "Ketton rag," may be named as a specimen of such material; and it is worthy of notice for the large quantity of cement between the ova, the interstices being filled up with a hard, beautifully crystalline, transparent cement, which adheres so firmly to the globules that a fractured surface of the stone presents almost all of them

broken—the same rend appears to pass as readily through the ova as through the cement, instead of the entire globules being separated from the cement, and leaving hollow, cup-shaped cavities.

If the ova be soft and chalky, with only a small quantity of cement, and that of a slightly crystalline character, such stone, if exposed to the weather, or to frequent alternations of wet and dry, will very soon begin to moulder away from the most exposed or most projecting parts. Large quantities of such kind of material are brought from the hills in the vicinity of Bath. The principal quarries are at Box, Combe Down, and Monckton Farleigh. The stone from each of these districts, and even in the same quarry, where there are generally a number of beds lying upon one another, is frequently found to differ in some of the minor characters from all the rest; such as being harder, coarser, more or less durable, &c., all of which are indiscriminately sold in the markets under the general name of "Bath stone;" and it rarely happens that an architect specifies what kind of Bath stone is to be used. It is always understood that the materials are to be good or of the best kind; and unfortunately it too often happens, that the stone which looks best when fresh from the workman's hands. is frequently of a description most subject to permanent decay, If it be left to the mason's choice, he is sure to select the stone that can be most expeditiously worked.

Bath stone has been used almost universally as a mineral substance for building in the city of Bath during a long period. The Abbey Church, which was not finished till after the Reformation, has been in great part restored within the last thirty or forty years. The west front has been richly ornamented, especially with the representation of Jacob's ladder on each tower, reaching from top to bottom, on which many angels are carved in bold relief: these have now mouldered away, till only a few faint traces remain, just sufficient to indicate where they originally were. This building, I am inclined to believe, is the oldest in existence of Bath stone, and beyond doubt not a very favourable specimen of its durability. The oldest of the modern buildings of similar material in that city, is, I imagine, Queen Square, erected in the beginning of the last century. The houses are ornamented with projecting mouldings, Corinthian capitals, &c.; and certainly they are not much decomposed, considering the time since they were erected.

It has been remarked, that Bath stone appears to stand the weather better in the neighbourhood of the quarries than it does if removed to a distance, or in London; and, judging from the present condition of the oldest houses at Bath, in comparison with Bath stone buildings of more modern date, erected in London, a casual observer might indulge his imagination with the idea of something being more congenial to the stone in its native atmosphere, than if removed to waste and perish in what may be termed a foreign climate. I am ready and willing to admit that there may be a very material difference between the air of Lombard Street, or the Royal Exchange, and that of the land of the cuckoo and the nightingale, or any other spot far from the busy world's unceasing sound. But I cannot conceive it probable, that a stone which would last for a century or more in the city of Bath, or its environs, would decompose in a quarter of that time were it placed in the Regent's Park. The plain matter of fact is, that the stone used in the construction of the oldest buildings at Bath, was procured from the Box quarries, which is, in the more important qualities, very superior to, and far more durable than, such as is now generally used. The Box quarry stone is still used, occasionally, in and about Bath, but the stone merchants in London have long since discovered that the masons will not buy it, on account of its being a little coarser and harder, and thereby more expensive to work.

Combe Down Bath stone was next introduced; it is finer-grained, softer, and less durable than the Box stone; but both these have been almost entirely superseded by the grand favourite from Monckton Farleigh, or what is usually called "Farleigh Down Bath stone." This material possesses all the qualities required by a hasty mason or contractor; it may be sawed dry like wood with a common peg-toothed saw more expeditiously than any other stone; an industrious workman may do almost as much work as he pleases in it; consequently a building may be executed in this stone in a shorter space of time than in any other; and lastly, it decomposes in a shorter space of time than any other stone; hence some people are inclined to think it "makes good for trade."

The restorations of Henry the Seventh's chapel at Westminster, were executed in Combe Down Bath stone between the years 1808 and 1821, at an expense to the nation of about £48,000. A large proportion of this amount was for the Bath stone, which has always been about as expensive in London as those of a more durable nature. If an additional £10,000 had been bestowed on labour, in all probability a material might have been selected, which would have lasted several centuries longer without being in so decomposing a condition. But whilst the lover of elegant architecture is admiring the extreme attention which has been bestowed in preserving the true spirit of the original design, he will be annoyed at discovering abundant evidence of premature decay. Many projecting parts of that beautiful fabric are conspicuously mouldering away in less than thirty years since they were restored. A casual observer might at one glance of the south-eastern towers convince himself of the truth of these statements; but on more attentive examination, a considerable portion of the masonry throughout the entire structure, especially the more exposed parts, will present multitudes of slight undulations or swellings, somewhat resembling in their progress gatherings or tumours under the skin; these increase in size and number until they meet each other, when they burst, and the surface falls off. This cankering process will be repeated as often as a fresh surface is exposed, until all architectural features are obliterated. Such is the lamentable condition and prospective state of Henry the Seventh's chapel at this time, that there is every probability of its being in the same dilapidated condition within thirty or forty years that it was in before the repairs were commenced in the year 1808.

That there are many stones in the building which at present show no symptoms of decomposition, is readily admitted; and those persons who advocate the use of Bath stone for such highly decorative purposes, frequently imagine that sufficient care has not been taken to place the stones on their natural bed. The importance of such precaution is generally very considerably overrated: I do not consider it signifies which way a stone is fixed, unless it presents a decidedly laminated structure, which scarcely ever occurs among the oolites. A stone of an open, powdery, and slightly cemented texture will, if exposed to the weather, decompose in a comparatively short space of time, in whatever direction it may be fixed, or whichever surface may be parallel to the horizon.

Another generally received fallacy is the opinion, that soft stone will become hard and durable by exposure. Although this notion is true to a certain extent, it is not of sufficient importance to warrant its application in architectural works. All kinds of stone, while

in the rock, or when recently quarried, are somewhat softer and more easily worked than after they have been exposed to the atmosphere a few months, owing to the stone in its original situation being more thoroughly saturated with moisture, than can ever be accomplished after it has been once allowed to get dry. This is a principle well known to masons, for it is a general practice amongst workmen to frequently wet a stone, especially if it be rather of a hard quality, during their operation of working it into mouldings or ornaments, to make it work, as they term it, "more kindly." If the stone be remarkably soft, it is advisable not to let it dry too fast after it has been taken from the quarry, for fear of its cracking, in consequence of the moisture being removed from the outside before the interior of the block can have had time to evaporate; hence, while the central part remains of its original size, and extremely damp, the surface will dry, shrink, and thereby cause many invisible cracks, the effect of which will be conspicuous after a sharp frost.

All free-working limestones and oolites become, in some degree, harder on their surface by exposure to weather. This arises from a very slight decomposition taking place, which will remove most of the softer particles, and leave the hardest and most durable to act as a protection to the remainder. In addition to which, the pores and interstices of the surface get filled with dust and dirt, washed in by rain assisted by powerful winds, all which circumstances help to secure the least protected grains from external violence. If the stone be naturally compact and durable, a surface of this description will materially assist its duration; but on the other hand, such materials as the Heddington stone, near Oxford, or the most perishable Bath stone, will in due time similarly obtain a hard crust, which, from the general body of the stone being loose and powdery, is not sufficiently compact to hold on; water will soak in behind the crust, cause a swelling and disruption on the surface, which ultimately breaks. The crust thus opened, gradually bends forward more and more, until finally the weight of the disintegrated portion causes it to fall off. In some instances, as in Bath stone, these defective places rarely exceed one inch or two of surface before the decomposed parts fall off; whereas the crust of the buildings at Oxford is so remarkably tenacious that it peels off and hangs like rags, often as much as a foot superficial before it entirely separates. Upon the whole I do not consider it a recommendation to a soft stone to say that it gradually becomes harder on the surface.

As Bath stone is decidedly one of the most fragile mineral substances ever used for building, a few observations on its cohesive strength may be offered, less on account of their utility, than because most persons who have investigated the subject of stone for building have expatiated considerably on this head. In all cases which have come within my notice, the stone possessing the least cohesive strength, or that which will crush with less pressure than any other, is nevertheless strong enough when once fixed for almost all practical purposes. No architectural members have to sustain greater pressure in proportion to their size than mullions of large Gothic windows. The tracery in the great north window of Westminster Hall is now executed in Bath stone, which is remarkable for having the least cohesive strength of all the specimens experimented upon and described in the report on the stone for the New Houses of Parliament. Some of the mullions of that window are less than 9 in. wide, and more than 40 ft. high, sustaining not only their own weight, but also the whole of the tracery behind the arch. The eastern window of Carlisle cathedral, built of a friable red sandstone, is 50 feet high; the mullions are smaller, and the tracery much heavier than that in Westminster, yet in neither of these examples are there any symptoms of crushing. The cohesive strength of stones is never more severely tested than during their conversion by workmen from the rough state to being fixed in their final situation in a building. During these operations, iron levers, jacks, lewises, and various other implements, are applied frequently without judgment, and with but little regard to the mechanical violence which a stone will bear; therefore it may be considered a useful practical rule, that, however soft a stone may be, if it resist the liability of damage until out of the mason's hands, there can be little doubt of its possessing sufficient cohesive strength for any kind of architectural work.

REVIEW.

Memoirs of the Literary and Philosophical Society of Manchester.

SECOND NOTICE.

THIS volume contains a mixed collection of papers, some of them purely literary, and others of a scientific character. We propose briefly to notice some of the latter.

An Account of some Experiments to determine the Quantity of Carbonic Acid in the Atmosphere. By William Hadfield.

This subject at the present time possesses great popular interest from its connexion with ventilation and the prevention of dry-rot. Carbonic acid is the injurious product which proceeds from the lungs after the air has been respired; it is also the fertile stimulant of that vegetable growth or fungus which produces the destruction so well known under the name of dry-rot. The proportion of carbonic acid evolved from the lungs affords an index to the quantity of air which has been breathed by an individual, because the carbon separated from the blood requires a proportionate quantity of oxygen to convert it into carbonic acid. Thus, in the example cited by Dr. Reid (see Lectures, at p. 209 of Journal), where a healthy subject is said to give out a product which contains three or four per cent. of carbonic acid, while in others the proportion amounts to six or seven per cent., it is evident that in the latter case twice as much air has been inspired, and therefore consumed, as in the other case. It is known that this acid is heavier than atmospheric air, on which account it is commonly found in the lowest situations, as in caverns, mines, and in deep wells. It is also produced extensively in common sewers, and otherwise in large towns, from the decomposition of animal and vegetable substances, from the combustion of certain kinds of fuel, and from the respiration of all kinds of animals. At the same time that carbonic acid is thus constantly being produced, it is said to be decomposed in the process of vegetation, the carbon being absorbed by vegetables, and the oxygen returning to the atmosphere. It is possible, therefore, that the quantity of carbonic acid in the atmosphere may have remained stationary from the beginning of the world, as the extent of carbon absorbed by vegetation may be supposed upon the whole surface of the earth about equal to the rate at which it is constantly being produced. Mr. Hadfield, however, observes that this decomposition of carbonic acid has not been satisfactorily proved.

The estimates which have hitherto been made of the proportion which the carbonic acid bears to the whole bulk of the atmosphere vary extremely, M. Humboldt having concluded that the air contained one per cent., while Mr. Dalton found from experiment that

the quantity was only $\frac{1}{1480}$ in one volume, or $\frac{1}{1000}$ in weight, and M. Saussure's experiments are said to show that the quantity is even less than that assigned by Mr. Dalton.

METHODS OF ESTIMATING THE PROPORTIONS.

"M. Saussure's method" says Mr. Hadfield "is toprocure a large glass globe of known capacity (one cubic foot or more), into which he passes a quantity of barytic water, more than sufficient to neutralize the carbonic acid in that volume of air. By agitation the carbonic acid is united to the barytes, forming an insoluble carbonate of the earth. The quantity of the carbonate so formed being carefully ascertained, affords data for determining the quantity of carbonic acid.

"Mr. Dalton considers a globe of one-fifth part of the size sufficiently ample, and uses limewater of a known strength instead of barytic, taking care to have more than enough to engage the acid gas. After the agitation and absorption the residue of lime water is poured out, and its reduced value is then ascertained, as it was before, by means of some test acid of a known strength: thus data are gained for the calculation of the carbonic acid engaged to the lime."

In the experiments made by himself, Mr. Hadfield followed the method of Mr. Dalton, using a glass bottle somewhat larger than the size which the latter considers sufficient. It will be unnecessary to give the separate particulars of Mr. Hadfield's experiments, but the results may be stated as follows:—

The greatest proportion by weight of carbonic acid which was found in a given quantity of air was that of 1 grain in 620 of air.

The least proportion that of 1 grain in 985 of air.

Also the greatest proportion by measure of carbonic acid which was found in a given quantity of air was that of 1 cubic inch in 947 inches of air.

The least proportion by measure, 1 inch in 1510 inches of air.

The mean of all the experiments, 1 in 811 by weight, and 1 in 1239 by measure.

An Account of some Experiments made to determine the Specific Gravities of the Steam and Vapour from Water—Alcohol—Ether—Pyroxilic Spirit—and Acetic Acid. By William Hadfield.

As it obviously requires great care and delicacy of experiment to determine the specific gravity of vapours, some of which are lighter, and others heavier, than atmospheric air, it may be instructive to those of our readers who may ever be required to undertake similar experiments to possess some account of the method pursued by Mr. Hadfield. It appears that we cannot more clearly express this account than in the author's own words.

"In determining the specific gravity of any elastic fluid, four things are essentially necessary to be ascertained, viz., *the volume, the pressure, the temperature,* and *the weight*. The specific gravity is the weight relatively to the weight of some other standard elastic fluid, when both are taken of the same *volume, pressure,* and *temperature*. The effects of volume, pressure, and temperature upon the weight are well known, and can be allowed for when one or all of these three data vary from the standard, as in practice frequently occurs.

The vapours of water, alcohol, ether, pyroxilic spirit, and acetic acid, are all compounds; the first of oxygen and hydrogen, the last three of oxygen, hydrogen, and carbon. The specific gravities of the three first-named vapours have been determined by Gay Lussac, and by other eminent chemists, with whose results I found my own to agree, except that in general I have made the vapours a little heavier than their results. The differences may possibly arise from errors in experimenting; though I took all possible care to avoid any source of fallacy, and repeated the trial on each vapour severally, in order that the errors, if any, might compensate each other. I may observe also in favour of my results, that I had great advantages in obtaining a high and steady temperature, by reason of a room capable of being heated to any degree between 200° and 250° Fah.: the chamber, which is 16 feet square, and nine feet high, formed of iron bars, 3 inches asunder, and beneath, at the distance of 9 feet, is the stove for heating it.

Before I began my experiments I had no knowledge whatever of the methods practised by other experimentalists. My experiments on the vapours of pyroxilic spirit and acetic acid are, I believe, the first that have been obtained. The apparatus which I employed consisted of a glass tube with a ball at the end; the tube being 42 inches long, with a bore of $\frac{3}{10}$ of an inch. The capacity of this tube is 4·64 cubic inches, and that of its ball 3·46, making together 8·1 cubic inches. In some cases I used a similar tube 40 inches long, and having a bore of nearly $\frac{4}{10}$ of an inch. Its capacity is 6·08 cubic inches, that of the ball, 4·3 cubic inches, making together 10·38 cubic inches. To ascertain the exact capacity, the ball was filled with mercury, and the weight of the fluid then ascertained.

The tube was then filled, and the additional weight of mercury determined. I next calculated how many grains of water the ball and tube would contain, the specific gravity of the mercury being considered 13·5; this was determined with each instrument, the trials being made independently of each other, and the weights found to agree. The tube and ball having been cleaned, carbonate of potash, previously made red-hot, and put into a small tube of filtering paper, was introduced into the open end of the tube, which was then inverted into a cup of mercury. It was then suffered to remain in this situation until the mercury stopped rising in the tube. The ball and tube were then filled with mercury, well boiled, and poured while hot into the tube through a paper funnel dried for the purpose. When filled, every bubble of air was carefully detached by a slender strip of whale-bone; the tube inverted into a basin of mercury was of course a barometer, the comparative accuracy of which was judged of by comparing it with a good standard instrument.

A small glass bulb was prepared, and its capacity determined by weighing it when filled with mercury. It was then filled with the liquid under examination, care being taken not to put in more than would be vapourized. This being done, it was again carefully weighed, and passed (the tube standing in a basin of mercury) up into the vacuum above; the basin and the tube containing the mercury were now attached to a wooden frame. A scale graduated to inches and tenths was attached on one side of the tube, and a thermometer on the other side, and the apparatus was now removed into the room before described, in which the temperature was at first 200°, and rose gradually for three days, until it became 250°. To secure a uniform temperature in the instrument, it was suspended in the middle of the room, out of the reach of all currents of air."

Mr. Hadfield gives tables containing the details of nine experiments upon the vapour of alcohol, and of twelve experiments upon each of the other vapours.

We gather from these the following results as the average of each set of experiments:

The specific gravity of atmospheric air is			1·
,,	,,	the vapour of water	0·626
,,	,,	,, alcohol	1·49
,,	,,	,, ether	2·55
,,	,,	pyroxilic spirit	1·27
,,	,,	acetic acid	2·37

Remarks on Dr. Thomson's Paper on the Combinations of Sulphuric Acid and Water. By Henry Hough Watson, Corresponding Member of the Society.

The first part of this paper relates to a remarkable result which takes place when sulphuric acid is chemically combined with water, that is, when it is so combined that the particles enter into chemical union with each other. It has been a generally received notion, that when these two fluids are thus combined, the volume of the mixture is less than the sum of the two separate volumes of the acid and water, and that owing to this condensation the specific gravity of the mixture is less than the mean of the specific gravities of the two separate fluids. This is the old and the generally received opinion; and to try the accuracy of this, Dr. Thomson undertook some experiments, the results of which he gave in a paper read before the British Association, in the year 1836. It appears that the Doctor, having calculated what the specific gravity of different atomic compounds of sulphuric acid and water ought to be, obtained by experiment a set of results highly anomalous with the calculated gravities, inasmuch as they exhibit neither a regularly increasing condensation, nor a regular expansion, according to the atomic quantities of the compound. Thus the Doctor found, from the comparison of his calculated results with his experimental results, that the compounds of one atom of oil of vitriol, with one, two, and three atoms of water, had specific gravities *above* the calculated mean, while the compounds of one atom of vitriol with four, five, six, seven, eight, and nine atoms of water, had specific gravities *below* the calculated mean. Mr. Watson disputes the accuracy of the Doctor's conclusions, and calculating the mean specific gravity in a different manner, determines, according to the Doctor's own experiments, a proportionate amount of condensation inversely as the atomic quantity of water combined with a constant quantity of the acid. Thus, when ten atoms of water are combined with one of acid, he finds that the specific gravity of the compound is by calculation 1·2082, whereas, by experiment, it was 1·2845, showing a difference arising from condensation of ·0763; also, where two atoms of water are combined with one of acid, the specific gravity of the compound by calculation is 1·6292, and by experiment 1·7837, showing here a condensation greater than the former, the difference here being ·1545. Throughout the intermediate combinations, also, the differences range between these two extremes in a tolerably correct proportion, considering that the experiments may not in all cases be absolutely free from error.

The remainder of Mr. Watson's paper is devoted to an examination of the quantity of heat evolved when an atom of vitriol is mixed with definite proportions of water, and here also the author, from experiments of his own, arrives at results which are widely at variance with those of Dr. Thomson. As this subject would require a lengthened space for explanation, in order to render it understood, and as, after all, it would not be generally interesting to our readers, we forbear giving any particular account of it, referring those who are interested in the inquiry to the book itself for further information.

The same want of general interest applies to another paper, by Mr. Watson, on the relative attractions of sulphuric acid for water. This paper, although not of a kind suitable even for abridgment in our columns, will be found highly interesting to students of chemistry and to manufacturers of sulphuric acid, as Mr. Watson explains, at the conclusion of it, certain views he has been led to entertain in reference to more economically conducting the manufacture of this article.

Process of Carbonizing Turf without close Vessels, the Peat furnishing its own Caloric without producing Ashes. By Dominique Albert, LL.D.

Dr. Albert describes three kinds of peat. "The white, or top of the moorland*, is the lightest, and consequently the worst; it is sold from four to five shillings the load. The brown, which comes from the second stratum, is much better, being more compact, and sells at five shillings and sixpence per load. The black, or best quality, sometimes called iron turf, is very hard and heavy; it gives an intense and sharp heat; produces a thick black smoke, with strong and unpleasant smell; it burns slowly, and is bought at six shillings. The incineration of the black turf leaves heavy reddish ashes, whilst those of white turf are of a sulphur yellow, and those of the brown have often a sort of orange tinge. . . . The white turf gives a fourth of its weight of charcoal, the brown a third, and the black one half."

The method used for making charcoal from turf, in Ireland, is a very cheap, simple, and primitive one, as they merely cover a red hot mass of glowing burning turf with large wet sods, newly cut, the effect of this being to confine the heat, in imitation of the action of a close furnace. By this expedient the turf is carbonized, or converted into charcoal; but, as the heap of burning turf rests on the bare ground, and as the wet turf itself will be partly carbonized, it is evident that the charcoal must be very impure, from the mixture of uncarbonized material, together with marl, sand, small stones, &c.

The Dutch carbonize "peat for domestic purposes in small conical furnaces, which are as common with them, in the country places, as the bread ovens are here." The turf in these furnaces is lighted from below, and when the combustion is nearly complete the top and bottom are closed. Although this method is superior to that practised in Ireland, the Doctor objects to it, because the charcoal it produces is not sufficiently pure, and because its application is not possible on a large scale.

After several trials, which Dr. Albert conducted with great care and patience, and one of which he found efficient for distilling wood, but inapplicable to the carbonization of peat, he succeeded beyond his utmost expectations upon the following plan, which he thus describes:

"I make two tunnels of inch board, nine feet high and eight inches square, with some hand-holes from distance to distance. These tunnels I place in the kiln along the side, in order that the bottom end may correspond with one of the four air-holes. One of my workmen descends then to the floor of the furnace, and forms an aerated bed with peat, by setting the cakes upright, with their tops inclined one towards another, so as to create a good draught, which must, as much as possible, run in the direction of both air-

* This description applies to the extensive turbaries, or peat moors of Chat Moss, and Barton Moss, in Lancashire.—Ed.

holes where the tunnels are standing. It is necessary for this operation that the cakes be entire and dry, as pieces would intercept the air, and a wet cake would paralyse the action of the fire. After the setting of this bed the peat is thrown down upon it, and left in the natural confusion of its fall, only it is required that a man places round the tunnels the turf cakes in regular order, to build like a chimney round these moveable tubes. When the kiln is filled and heaped up about three feet above the level of the hole, the tunnels are drawn out by means of their hand-holes, and leave two square passages from top to bottom. In these temporary chimneys a few incandescent peat cakes are thrown, and in these some broken pieces of turf, till the passages are filled; but, as the air plays more freely through these former chimneys, some barrowfuls of peat crumbs will shut the too wide pores, which places are easily seen by the greater volume of smoke escaping from them. The kiln, left open to facilitate a more general conflagration, is not covered before the heap of turf cakes has sunk to the level of the brick-work. In this state the cover is let down, and some soil is brought round its border to intercept the escape of smoke. In this stage of carbonization all the air-holes, with the large and small chimneys, are open.

"As soon as the fire is perceived through either of the small chimneys corresponding with the passages where the fire has been lighted, the horizontal mouth of the same air-hole is to be shut with a piece of brick and some marl, and the others are to be successively stopped in the same way, the moment the redness of the fire can be distinguished. If there remains any doubt of the perfection of the operation, a pole about fourteen feet long should be thrust through the hole where the carbonization appears incomplete, and, by thus gauging to the bottom of the furnace, you will immediately be aware of the state of the charcoal, which you can remedy instantly by opening the air-hole opposite the place examined.

"When the smoke begins to abate, you place the cover on the central chimney, but so as to shut only the half of the aperture, taking care, at the same time, to direct the open part of the cover towards that part of the kiln which you might consider not so perfect as the remainder. At last, when the eruption of smoke has ceased, you shut all chimneys immediately, and the operation is at an end. It requires generally 24 hours to complete the carbonization of one furnace, and 60 hours for carbonization and cooling of the charcoal. A kiln of these dimensions can receive between three and four one-horse loads of peat, of about fourteen hundred-weight."

With these plain and simple instructions, no one can be at a loss for a ready and economical method of converting peat into charcoal. It may be almost unnecessary to remind our agricultural readers, that the ashes of peat are esteemed an excellent manure for grass and clover. Dr. Albert states, that they owe their alkaline quality chiefly to the presence of lime, and they are used as a manure in the north of France, and in Belgium. "March and April are the best months to use them. They are generally sown during damp weather, and will have a good effect used with any plant, at its first appearance above ground."

Mr. Heywood's Paper on the Coal District of South Lancashire, Contains several tabular sections of the coal measures, and is accompanied by a geological map of the district; but it would be impossible to do justice to this paper without quoting it at full length, nor could a mere abstract of it present any useful information.

Observations on Sculpture. By Paul Moon James, Esq.

This is an admirably written sketch, in which the author, after some beautiful allusions to the imaginative sculpture of the Greeks, and the more material style of the Romans, and after introducing for illustration the most splendid works of Phidias and Praxiteles, proceeds to a review of the most famous English sculptors, commencing with Grinley Gibbons, who flourished in the time of the second Charles and his successor, and ending with Flaxman and Chantrey, the great masters of our own times.

The following concluding remarks are well worthy of attention, and may serve to inspire the student with a more exact perception of the difference between ancient and modern sculpture, and elevate his mind to a more faithful apprehension of the forms and compositions, which are really graceful, beautiful, and dignified in sculpture: "There is this difference between the ancient statues and the modern ones. The former convey their own lessons to the mind, and are in themselves an authority in forming a perfect judgment, and a standard for everything that is beautiful and correct in taste. Who ever looked upon the Apollo, the Antinous, or the Diana, and did not concede all artificial dogmas of criticism, as in the presence of a great Master and Teacher, and felt disposed implicitly to receive the principles of art, as perfect and unimpeachable, embodied in their forms and expressions!

"In this class of the imaginative the ancients maintain their great superiority, and the moderns do not pretend to put forward one rival near their throne. There are, indeed, very few instances in modern sculpture, where the statue fills the mind with its own thoughts, and teaches the soul whilst it forms the taste. Some few there are, but in general we reverse the order of critical rule, as before described; and now, remembering the principles of taste, we ask if the statue before us is executed according to those principles. In the ancients we receive them *from* the statue; in the modern we apply them *to* the statue; and how many there are that will not bear the test. From these we learn that the extreme accuracy of portraits, combined with the minute details of coat, buttons, and button-holes, produce a poor and mean effect; that the naked body, the enigmatical hieroglyphic, the scanty drapery, the out-of-date victories and virtues, are unsuitable and preposterous. The sculptor, gifted with genius, may safely take Truth and Nature for his guide, and Taste and Imagination for his instructors. There is ample scope in these, without deviating into remote and fanciful allegory, or wandering from the fidelity of resemblance. A statue should be like, but the personal likeness should not predominate over the expression of mental character; and the introduction of adventitious drapery may display the skill of the artist, whilst it may overcome the ungainly stiffness of modern costume. So in landscape painting; the painter preserves the truth and feeling of the landscape by depicting the light, the shadows, and the character of the scene, together with the natural local objects. And by this art the work of genius is distinguished from the dull, formal, and exact outline produced by the mechanical process of the Camera Lucida. The portrait painter also, such as the late Sir Thomas Lawrence, not merely transfers a likeness to his canvas, but combines with it expression, animation, and grace, until the portrait becomes a memorial of mental qualities, as well as of individual proportions.

"And it is in this way that the sculptor copies nature, and so appeals to the affections and sensibility of the spectator. He

embellishes with taste and imagination, and thus awakens in the minds of others ideas of grace, beauty, or genius."

Dr. Dalton's Paper on the Barometer, Thermometer, and Rain at Manchester,

Is a summary of various essays on Meteorology read before the Society between the years 1830 and 1840.

The valuable tables on barometric heights, of heat, and of the quantities of rain, embrace a period of forty-seven years, namely, from 1794 to 1840 inclusive. These tables are highly interesting, and those relating to the fall of rain are particularly valuable to engineers, and to all others engaged in canal works, water-works, drainage, irrigation, or any other hydraulic operation.

The following remark is curious:—

"Rain is a great regulator of temperature both in summer and winter. Rain is the cause of cold in summer, and of heat in winter: the reason is pretty obvious. Clouds in summer prevent the earth being heated by the sun's rays; and rain causes a copious evaporation, requiring a proportionate expenditure of heat. In winter the vapour is chiefly imported from the south and south-west, and, being deposited here, the heat arising from the condensation of the vapour is diffused through the atmosphere, and the evaporation in that season being insignificant, it requires no material supply of heat. Hence, we have a well-founded maxim for this climate: *that a wet summer is a cold one, and a wet winter a warm one.*"

On the Sepulchral Monuments of Sardis and Mycenæ; and Remarks on the Mural Architecture of Remote Ages. By William Rathbone Greg, Esq.

It is difficult to make any abridgment of these two excellent papers, in which Mr. Greg brings together some facts and speculations of great interest to the antiquary.

It is remarkable that sepulchral monuments have outlived all other efforts of human construction. So securely, and of such imperishable materials, did the ancients construct the last resting-place for the ashes of their kings and their heroes, that these have commonly outlived the grandeur of the one, and the conquests of the other; and while the memory and the fame of him who reared and of him who inhabits are alike forgotten, the tomb still stands, the solitary occupant of the desolate plain, where once were cities with lofty walls, and towers, and temples, and palaces, the last sole relic of all whose greatness is the tomb of some king, some priest, or it may be of some menial who served in their once stately halls.

"On the plain of Troy," says Mr. Greg, "the Tumuli are the only remaining monuments of a time celebrated beyond all others in the history of mankind; the Pyramids of Egypt have long survived the cities of the monarch who erected them; at Mycenæ the Tombs of the Atridæ may be seen in their original integrity, though their Palaces have left no vestige behind them, and their massive citadel is fast crumbling into ruins; and of the renowned and magnificent Sardis, the only uninjured relic which has reached our times, is the sepulchre of the sovereign who first raised it into splendour."

Mr. Greg visited the celebrated *Barrows* of Sardis and Mycenæ, the latter of which cities is said to have been founded by Perseus about 1300 B.C. It is situate in the vast amphitheatre of hills which half surround the plain of Argos in the north-east of the Morea. Mr. Greg thus describes the celebrated *Gate of Lions*, the entrance to the Acropolis of Mycenæ, and the one through which Agamemnon led his army to the siege of Troy. "It is formed of two upright slabs of stone, 17 feet high, and supporting an entablature of similar proportions, viz., 15 feet long, 6½ feet thick, and 4 feet deep, hewn out of a single block. Resting upon this entablature is a triangular slab, 10 feet high, containing in relief the figures of two Lions, standing on their hind legs on each side of a pillar, the summit of which has been broken off."

The mound, which is the more immediate subject of Mr. Greg's paper, stands about 50 yards from the gate, and outside the walls of the Acropolis. "It is a large, round, conical hill, partly natural, partly artificial, and considerably lower on one side than on the other. On the side nearest to the citadel, an excavation has been made, which succeeded in laying bare the entrance or door-way, a structure of even more gigantic dimensions than the Gate of Lions. On entering this, we come into a large vaulted chamber, inclining to the conical form, 50 feet across at the base, and about 45 feet high. Adjoining this, is an interior chamber, of square form, and smaller dimensions. The chief peculiarity in this beautiful monument struck me as being the extreme neatness and regularity of the masonry. It contains forty courses of hewn stone, all admirably fitted together, but without cement, and it is, I should think, quite as perfect a specimen of workmanship as could be produced at the present day."

Different opinions have been held by the learned on the subject of this monument, some calling it the Tomb of Agamemnon, and others the Treasury of Athens.

Mr. Greg thus describes the sepulchre of Alyattes, at Sardis: "The Gygian Lake is a wide piece of water, by the banks of which, on the side nearest to the town, are great numbers of barrows, or mounds of earth, and among them the Sepulchre of Alyattes stands pre-eminent. Herodotus, (lib. 1. § xciii.,) who probably lived about 450 B.C., speaks of it as being, next to the works of the Egyptians and Babylonians, the most stupendous monument existing. It was constructed, he says, upon a foundation of stone, and afterwards completed with earth. It was erected by three classes of the inhabitants of Sardis, viz., the merchants, the artisans, and the public women. At the summit of it were fixed five termini, or small pillars, with inscriptions, declaring the proportion of work executed by each class of the artificers; of these there is now no vestige. In the time of Herodotus, this monument was somewhat more than three quarters of a mile in circumference at the base, but at present it is considerably less. Unfortunately he does not mention its height, nor had I, when there, the means of measuring it, but it could not fall far short of 200 feet. Several attempts have been made to effect an entrance into the monument, under the idea that treasures would be found there; but hitherto little more has been done than to scratch the surface; and the interior construction of one of the most ancient sepulchres in the world (B.C. 560) is still a secret.

Though there is less of mystery, there is scarcely less of interest, connected with this enormous barrow, than with the one at Mycenæ. We know, beyond all doubt, that it is the monument of Alyattes, the father of Crœsus, and the king of Lydia. We know that it was erected by order of the wealthiest monarch of Asia, that it was described by Herodotus, and that it must have been visited by Solon; and there is surely enough of magic in these associations to awaken our warmest sympathies for this mighty relic of a people, whose

fertile empire is now a desert, and whose once formidable name is almost lost in the remoteness of past time."

Mr. Greg's second paper treats of the remains of Cyclopian, Pelasgic, and Etruscan architecture, and is no less interesting than the one from which we have already so largely quoted. The people called the Cyclopes, to whom the Cyclopian remains are attributed, are supposed by Mr. Greg to have existed in Greece more than thirty-two centuries ago. They are supposed to have made great advances in the mechanical arts, and to have been employed in constructing fortresses for the chieftains of Greece before the siege of Troy.

The historians and poets of Greece and Rome have handed down many fabulous traditions of their Cyclopian forefathers. They were commonly described as giants; the invention of iron is attributed to them by Pliny, and Euripides describes them as "sons of Neptune, one-eyed, homicides, and cannibals." These wild ideas of the personal prowess, the mechanical skill, and fiendish character of the Cyclopians, are with great appearance of probability ascribed by Mr. Greg to the astonishment with which their gigantic structures were viewed by the Greeks, at a time when their own skill and strength appeared quite inadequate to effect such combinations. It was natural enough that the fancy of the poet should colour the tradition which told of a people who, in far distant ages, had reared enormous walls, and domes, and gateways, composed of mighty stones, which appeared immoveable by any of the appliances with which themselves or their contemporaries were acquainted: and hence, instead of sober and rational descriptions of men, differing from themselves in their superior knowledge of certain of the ruder sciences, which yet endow mankind with power over the material world, we are taught to identify the Cyclops with all that is terrible, uncouth, and super-human. The remains of their grand and massive architecture are yet exceedingly rude, consisting "of immense *amorphous* blocks of unhewn stone, laid one upon another, and having the interstices filled up with stones of a smaller size."

The Pelasgic, or Polygonal style, is distinguished from the Cyclopian by the exact fitting of all the blocks composing the face of the wall, so that no interstices are left, and the vertical face presents the appearance of a pavement of irregular polygons, accurately fitted and adjusted to each other at all their sides and angles. The Pelasgic walls may be seen "in their greatest perfection at Gortis and Mycenæ, in Greece, and at Norba, Segni, Cora, Alatri, and various other ancient situations in Italy."

The great distinction between this and the Cyclopian style is, that the walls of the latter consist of unhewn and amorphous masses, while the Pelasgic walls are built of hewn stones, often approaching to the form of regular polygons, particularly to that of the pentagon and the hexagon. There is great difference of opinion amongst the learned, however, as to whether the two styles are really the work of different people, or even of different ages. Mr. Greg, who has himself seen all the remains which he describes, professes himself unable to decide with certainty, whether the styles are referrible to distinct ages and distinct people, but concludes that the styles themselves are quite distinct in their character. Of the people called the Pelasgi, "perhaps," says Mr. Greg, "the sum of our actual information regarding them may be comprised in the following meagre facts: that they were not one nation, but a number of tribes; that they were wanderers; that they existed long before the historical era; and that they either inhabited or overran at different times the greater part of Greece and Italy."

We now come to the third style of ancient mural architecture, namely, that which has been called the Etruscan, and which, from the courses being horizontal, approaches much more nearly to the appearance of the modern wall than either of the former. This style "is distinguished by the vast uncemented masses of which it is composed being arranged in horizontal courses," and there appears no reason to doubt the propriety of ascribing it to the Etruscans, whose name it bears.

Mr. Greg thinks, that the object of the ancients in choosing so peculiar a style as the polygonal, which must have required greater labour and greater skill than the regular cubes of the Etruscans, is to be traced to an opinion that walls so composed were more capable of resisting earthquakes, to which the country where they are found has been particularly subject. If this, indeed, has been the motive for so constructing their walls, the desired end of their preservation has been well accomplished, as no instance appears where any of them have suffered from subterranean convulsions, an agency which would undoubtedly prove highly destructive to masonry in regular horizontal courses, particularly when we consider that no cement was used in building the walls of either style.

Respecting the stupendous fortifications in which these styles of building are found, Mr. Greg concludes,—

"That they all took their origin before the birth of authentic history, and that some of them have already defied the hand of time for upwards of thirty centuries; that they were the productions of different times, if not of different people: that they were erected by a people possessed of a high degree of mechanical skill, and considerable command of machinery, and sufficiently civilized to build for succeeding ages, who existed at a period when we are accustomed to consider the whole of Europe as plunged in the darkest barbarism."

Geology of England and Wales. London: Bell and Wood.

MIDDLESEX, AND PORTIONS OF THE ADJOINING COUNTIES—PARTS OF SURREY AND SUSSEX.

We have here before us the two first sheets of a new work, specially on the geology of this country, with an accompanying series of geological papers, by Mr. Samuel Hughes, civil engineer; by whom also the divisions of the strata have been marked out on the map, on the authority of the best geologists, and from personal researches. We have great pleasure in recommending this work to our readers, as containing a great mass of useful practical information connected with engineering and economic geology, while the scale of the map is on a sufficient size (one third of an inch to a mile,) to show numerous subdivisions and variations of strata, which are necessarily omitted, or very imperfectly shown, on the ordinary geological maps.

The letter-press is remarkable for the novelty of being written by an engineer who has devoted himself with great assiduity to the study of practical geology, particularly with reference to its application in engineering works. His researches, embodied in these papers, must therefore be particularly valuable to engineers, agriculturists, and all others who are interested in economic geology.

We quote from the first part of the work the following particulars, relating to the phenomena of water and springs in the neighbourhood of London:—

"The London clay itself is, from its nature, destitute of water, although there are numerous wells in and about the metropolis, which derive their supply from the diluvium which covers it. The water from these wells, however, is by no means of the fine soft quality procured from the deep wells sunk through the London clay into the sands of the plastic clay. The depth to which it is necessary to sink, in order to procure this water, varies according to the undulations of the water-bearing stratum. In London itself, it appears to be about 200 feet below the level of the Thames. On the north side of London, as at Tottenham and Epping, from 60 to 80 feet below the same level; while on the east side of London, the depth is very inconsiderable, varying from 8 to 50 or 60 feet below high-water mark. The wells in Essex are mostly of great depth, but this is principally on account of the general elevation of the country, which renders it necessary to penetrate through a great mass of the London clay, sometimes nearly 500 feet, before the same sands can be reached, which at Tottenham and Mile End are found at from 100 to 120 feet below the surface. The rise of water in wells sunk into the London clay, forms at this time a subject of great interest, when so many projects have been brought forward with reference to the supply of water to the metropolis from a distance. Scarcely is it possible to lay down anything approaching to a law which regulates this phenomenon, since, in wells a very short distance from each other, the level to which the water rises is by no means the same. If we suppose a subterranean sheet of water percolating freely through the sands of the plastic clay, it is evident that in wells the water ought to rise to the same height as the lowest level at which it can flow over the surface, or to the level of the lowest natural dam. Now on the east side of London, the sands of the plastic clay have been laid bare and denuded at several places along the valley of the Thames, so that on theoretical grounds it could not be predicted that the water should rise higher than the level of the river, which is the present natural outlet for the water received into, and penetrating through, the sand. This prediction is verified in the case of wells sunk in the neighbourhood of Bow, Stratford, and West Ham, since in these the water does not really rise above high-water mark. But in other parts of the London clay district, the rise of the water is by no means limited to this height, as in many parts of Essex it rises even as much as 330 feet above the level of the Thames. It is proved from this and similar facts that the percolation of water through the sands, instead of being uninterrupted, is extremely irregular, and so imperfect that it is almost impossible to judge with certainty what will be the result of sinking in any particular locality. There can be no great risk, however, in assuming, with reference to any particular boring, that the water will rise at least as high as the nearest point of natural drainage."

The following observations on the chalk district will be particularly interesting at this time, from their reference to Mr. Stephenson's project of procuring an immense supply of water from the chalk of Watford.

"In proceeding to investigate the circumstances under which a porous formation, like the chalk, may be expected to yield water in wells or borings, it is important to observe the natural hydrographical aspect presented by the chalk surface in different parts of England. For instance, along the whole range of the North and South Downs, if we except the intermitting stream called the Ravensbourne, the uniformly arid nature of the surface is not varied by a single streamlet, nor is a spring to be found anywhere on the surface of this chalk, except in the situation already described, where the lowest marly beds give rise to springs at a level far below the general surface of the Downs. But in the great development of chalk in Wiltshire and Hants, and, in fact, more or less throughout the whole of the chalk country on the west and north sides of the London basin, streams of all sizes rise from the chalk, and flow over its surface.

"To what, then, is this remarkable difference due? Principally, no doubt, to the position occupied by the chalk in connexion with the impervious strata on which it rests. Whatever may be the retentive capacity of the lower marly beds in different varieties of chalk, it may be laid down as a general rule, that water, in any considerable quantity, is never met with much above the level of the gault, which serves in fact as a barrier or dam to keep up to its own level the water which has penetrated the chalk. Hence, if the arrangement of these strata in any district be such that the whole surface of the chalk is greatly elevated above the gault, it is obvious that the water sinking freely downwards through the chalk will nowhere seek an open channel on the surface until arrived at the level of the gault. Below this level the porous beds of the chalk and green sand are already saturated with water, and therefore the new supplies furnished by rain and snow, after having filtered through the chalk down to this level, will break out and flow over the surface. Now, in the elevated ranges of chalk, the position in which this effect takes place is not less than from 300 to 400 feet below the general level of the Downs, so that in such districts the area of chalk country lying below the level of the gault is in extent quite insignificant, consisting of about 100 yards in breadth on the outcrop side of the chalk summit, and of a few narrow valleys which run up from the plastic clay into the chalk country; and these, under such circumstances, comprise the only part of the whole vast surface occupied by the chalk formation which is irrigated by natural streams. The great mass of chalk composing the Downs is, therefore, quite dry, and it is generally found that borings in the higher parts of the range have to pass through many hundred feet before a drop of water can be procured. But in the less elevated districts of chalk, as in the counties of Bucks, Herts, and Cambridge, the level of the gault is not remarkably below the general level of the chalk, which in this part of England is nowhere distinguished by the bold mountainous features which prevail in the south-eastern counties. The chalk of Hertfordshire, in particular, is traversed by numerous valleys, which are watered by copious and constantly flowing streams, a peculiarity which, no less than its main physical features, distinguishes it, in the eyes of the agriculturist, from the dry and barren Downs of the south. The valleys in which these streams flow are usually about the same level as that of the gault, which is here, therefore, the means of irrigating a vast extent of chalk country lying below its own level. It is remarkable that the streams which rise in the chalk of Herts and Bucks, as the rivers Verulam and Coln, together with those of the Chesham, Amersham, and High Wycombe valleys, all flow in the same direction as the dip of the chalk, whereas the small streams which rise in the Surrey and Sussex Downs, flow off the chalk and in a direction contrary to its dip.

It will now appear obvious why borings which penetrate the chalk of Hertfordshire to a very small depth, namely, to the level of the valleys in which streams already exist, should meet with water in abundance, for in such borings the water will evidently stand at the same level as that of the streams which now rise in the

country. Wherever, therefore, an opening is made in the valleys of the Hertfordshire chalk, an abundant supply of water flows into it, a fact which was remarkably confirmed during the progress of the deep cutting through this chalk on the London and Birmingham Railway. The chalk was there found completely saturated with water, of which so large a quantity broke out in the cutting as to maintain a constant stream at the foot of each slope, and the works would have been completely inundated, if ample provision had not been made for its discharge, at the lower end of the cutting.

With a great fund of theoretical knowledge, fortified by a still more valuable experience, derived from the extensive chalk cuttings on the London and Birmingham Railway, Mr. Stephenson, engineer-in-chief of that line, has pledged himself in the most decided manner as to the practicability of obtaining for the metropolis a great supply of water from the chalk at Watford. To this proposal it has been objected, that the neighbourhood, from which the supply is to be taken, would be greatly injured by having the water drained from its wells, and the sources of local supply diverted; but when we consider the vast reservoir afforded by the chalk for all the water falling on it, and when we know by positive proof that over a very large district the water now stands permanently in the chalk at a fixed level, we can scarcely hesitate to pronounce such apprehensions groundless."

A Descriptive and Historical Account of Hydraulic and other Machines for raising Water, ancient and modern. By Thomas Ewbank. London: Tilt and Bogue, 1842.

This work is eminently entitled to be called a history of the human race, since it carries us forward from one stage to another of advancing civilization, beginning with the rudest and most simple efforts of ingenuity, to the almost immeasurably superior wonders of our own day, as exhibited in the gigantic power of the steam engine throughout the unbounded field of its labours. It is true, that in this history we are not treated with the exploits of kings and statesmen, and warriors, those immemorial idols of the vulgar mind, to whom alone it has been customary to confine the appellation of hero. The names which figure in these pages are not linked with narratives of bloodshed and murder; they are not the names of men who have subdued their own species; not of men who have conquered other men, but of those who in all ages have triumphed over and subdued the elements, and rendered *them* subservient and obedient to the uses, the commands, and convenience of the human race. Those who, by the force of intellect, and by the energy of their minds, directed to the peaceful seeking and improvement of philosophical truth, have contributed to advance the dignity of mankind, how incontestably have they been the agents and the instruments of Providence, in conferring inestimable benefits on their species; and those others—all those who, till very modern times, have figured pre-eminent in all histories, as the excellent of the earth, the great, the mighty, the heroic, how plainly does the voice of truth brand them as the destroying scourges, who have dealt out, with a measure more or less full, the wrath of Heaven appointed in its wisdom to rebuke and punish the sons of men. Thus, then, while some men have been sent on earth to confer blessings and comfort on their species, throughout all posterity, others have been the appointed instruments of fulfilling curses, and carrying desolation, over the fairest scenes of nature and domestic life. It will scarcely be questioned at this day whether the deeds of the former or the latter class are most worthy of record, and which of them are most worthy to be admired and imitated by their descendants. Well might the philosophical Robertson lament the cruel mortification of finding that all past history was filled with the exploits of conquerors, and the freaks of tyrants, who have desolated the earth, and rendered nations unhappy, "while the discovery of useful arts, and the progress of the most beneficial branches of commerce, are passed over in silence, and suffered to sink into oblivion."

It would probably be impossible to select a fitter subject than that of practical hydraulics, embracing an account of all the various contrivances practised for raising water at different times, and amongst different people, to illustrate a true philosophical history of the human race; and therefore the book before us, supposing it to be, as it really is, what its title professes, would afford groundwork for philosophical reflections and conclusions of a high order.

Whoever consults history with enlarged and enlightened views of the true objects for which history should ever be written, will be led to trace, even in the first designs of Providence, with respect to man, an evident connexion between the scenes of his earliest labours, the soil he first trod upon earth, and the development of those powers and of that ingenuity, which was destined, in every succeeding age, to lighten his labours, to reward his toils, and to enlarge the sphere of his happiness and enjoyment. Thus, how remarkably were Hindostan, Egypt, and China, those cradles of infant man, adapted by their soil and climate to call forth his ingenuity, and how successfully did they compel it to exert its earliest efforts in more largely diffusing water, that great agent and necessary aid to vegetable growth. It seemed, too, that man was first placed in the vicinity of the Nile, that he might learn from nature the first lessons in irrigation. He would there see the lands periodically flooded by the waters of this great river yield overflowing harvests in return for the welcome visitation, and, profiting by the lesson, it is not to be wondered at that some of the earliest machines ever used in agriculture were designed for the purpose of raising water to irrigate the land.

Rude and simple indeed were these machines, and scarcely entitled to the name of hydraulic implements, for they were merely contrivances by which men could themselves carry about the water from one place to another. Such are the calabash and the yoke, which appear to be of immense antiquity, as we are informed that some of the earliest Egyptian hieroglyphics represent men carrying water by means of the yoke; and we learn from the Scriptures that the children of Israel were thus employed in Egypt; the yoke there spoken of being evidently that used in carrying water, from the expression, "God broke the bands of their yoke, and made them go upright," alluding to the stooping position occasioned by labouring with the yoke.

Successive improvements followed the yoke, among the most important and the most ancient of which was the swape, consisting of a long lever resting on a raised fulcrum by the side of the well or the river, and having a bucket suspended from the end of it. This contrivance, so ancient and simple, is extensively used to this very day, and this not only in India and other eastern nations, but examples of it may be seen in this country and in Ireland. Water is often raised to considerable heights by this contrivance, several swapes being fixed one above the other at different stages.

Whether viewed as a purely philosophical work, or as a comprehensive text-book for mechanics and inventors, Mr. Ewbank's book is equally valuable. The mass of information it contains is unusually great, and the immense variety of machines which it describes are illustrated by about three hundred engravings. It is capable of saving infinite trouble and mortification to inventors, by putting them in possession of all that has been done in the way of hydraulic invention, and thus the pains may often be saved of inventing over again that which has been already discovered and applied.

We have seldom seen a more instructive and amusing work, and the following brief notes taken from it will give some idea of the range of interesting subjects which are noticed, although they do not bear immediately on the subject of hydraulics:—

"It is a little singular that the Egyptians had a religious rite in which, as in modern Lent, every person ate fish. Cattle were branded with the names of their owners. Beer was an Egyptian beverage, and onions a favourite esculent. At feasts they had music and dancing, castanets, and even the *pirouette* of the Italian and French *artistes*. They had *grace* at meals, and wore wreaths of flowers and nosegays. Goldsmiths in their shops are shown with bellows, crucibles, blowpipes, and furnaces. Carpenters' and cabinet-makers' shops are represented, from which, and from specimens of work extant, we learn that *dove-tailing* and doweling, glue and veneering were common. The leather-cutters' knife had a semicircular blade. Shoe and sandal makers had straight and *bent* awls: the bristle at the end of the thread does not appear to have been used. Lastly, Egyptian ladies wore their hair plaited and curled; they had mirrors, needles, pins, and jewellery in great abundance. Their children had dolls and other toys; the gentlemen used walking canes, and wore wigs, which were common."

We shall offer no apology for this delightful medley, which is characteristic of an occasional digressive spirit of the author.

We are unwilling to extend this article by quoting at greater length from the work. In our last number, however, will be found an extract on the subject of wells, and we may also in future occasionally take the liberty of borrowing a little from its very interesting contents.

THE HARBOUR QUESTION—BAYS VERSUS PROMONTORIES.

TO THE EDITOR.

SIR,

HAVING, in a previous letter referring solely to the subject of the cause of the existence of bars, engaged to notice your observations in your Journal for September, in which my name is introduced as differing from yourself and Mr. Barrett on the subject of the proper position for the formation of "Harbours of Refuge," I beg to state I continue to hold the same opinion, and do not think with you, "that promontories are the proper places for such harbours, and that in no bights or bays where there are deposits of alluvial matter ought they to be so placed."

My dissent is particularly given to your position that promontories are the proper places for the formation of harbours of refuge, and I believe that you will not hold this position when you are informed that many promontories, and particularly Mr. Barrett's selections of Dungeness and Lowestoffe, are mere promontories of sand or shingle, which have been for ages extending into the sea.

If, as you state, harbours ought not to be constructed in bights or bays, then, according to this, your opinion, it was a very unwise work to have constructed Kingstown Harbour; an equally great error to have formed the Plymouth breakwater; and our neighbours were also wrong in executing the equally splendid harbour of Cherbourg: all these, and many other harbours of vast utility, have all been made in the situations Mr. Barrett and yourself condemn.

You term Ramsgate harbour a promontory harbour, but Ramsgate is really situated in a bight.

Without, however, troubling your readers further with my opinion as to which is, or which is not, the best situation for a harbour of refuge, let any of your readers "go along shore," beginning with the intelligent masters of the Scotch smacks, and ending with the hardy Durham and Northumbrian masters, and one and all will say, that "the proper place for a harbour of refuge must be at the bottom of a great bight, or in the most leeward position, during the most dangerous in-shore gales," because it is into such that vessels get embayed, when they are no longer able to keep off shore. What sailor would expatiate on the benefits of a harbour to windward of him, when his vessel was at the time driving before the gale bodily on shore?

I am, Sir, your obedient servant,

Newcastle-on-Tyne,
Sept. 17, 1842.

W. A. BROOKS.

[We reserve our remarks on this subject, and on that of the formation of bars, to give our correspondents an opportunity of first expressing their opinions. See the following letter by W. G., in answer to Mr. Brooks, of last month.—ED.]

BARS OF RIVERS—THEIR ORIGIN ATTRIBUTED PRINCIPALLY TO THE ACTION OF THE WAVES.

TO THE EDITOR.

SIR,

I OBSERVE in your Journal for October last, a letter from Mr. Brooks, on the formation of bars at the mouths of rivers. Now, as this letter is an answer to some remarks which appeared in your Journal on the subject, and is intended especially for the purpose of placing in a clear and distinct view the opinions of Mr. B. on the cause of bars, I infer that it is the substance and conclusion of his whole theory.

Mr. B. states, "that the greater the fall of the surface of the river, if taken at low water in a given length of channel, by so much the worse will be the condition of the bar." I believe that this may be the condition under which bars are sometimes found, but, at the same time, this is far from being their cause. A great fall in the surface of a river as far as the tidal efflux extends, together with the volume of water discharged by it, must give to its waters a greater impetus towards the sea than had been given by the tidal influx in an opposite direction. And, further, no permanent diminution of velocity could take place without an increase of its sectional area; for it is a well-known theorem, that the velocity of water flowing in rivers is inversely as the sectional area. Now, as the depth of water on bars is less than in other parts of rivers, the velocity will be proportionably greater, therefore no deposition can take place on the bars from diminished velocity of the river.

Having now shown that no bar can be the result of mechanical deposition, at the mouth of a river so circumstanced, it is necessary to state how they are formed.

The extensive banks of sand and shingle which form the natural bounds of the ocean in numerous places, show distinctly the process by which bars have their origin. Where the depth of the sea is not great, and is bounded by a gradually sloping shore, covered by sand and shingle, each successive wave impinging on the ocean's bed carries with it a portion of this matter, and leaves it where its motion changes. It is in the action of waves on a lee-shore that we recognize one of the most potent agencies of nature, tearing away the most solid materials of the ocean's bounds, and rolling them about in millions like so many toys, until they assume all the varied forms of sand and shingle, here spreading them in strands, and there piling them in banks, wherever the waves attain a state of repose. A most instructive example presents itself from near the church of Reculver to the Isle of Thanet; a bank of shingle 30 or 40 feet high, and, in many instances, 100 or 200 feet wide, extends quite across the low ground, which was formerly a channel separating the Isle of Thanet from the main land. Here no difference of tidal influx or reflux interfered, but still a bar to these waves has been raised by their own agency. The waves of the ocean—these are the bar-making agents, and if we would improve the condition of bars, we must protect the mouths of rivers from their influence. Numerous other instances similar to that adjoining the Isle of Thanet might be given, but it is quite unnecessary, for there is scarcely a portion of low, exposed coast throughout the whole extent of the British Isles that does not furnish them.

Mr. B. adduces the Thames and the Humber rivers as not under the influence of this bar-producing theory; and so they are beyond its influence, and so are all rivers which enter the sea by wide and long estuaries. The waves of the sea—these physical bar-producing agents—lose their power by rolling into a long estuary, and before they reach what is properly the mouth of the river, they have returned to a quiescent state. Now, we know that the influence of waves does not extend to a great depth,—they constitute little more than a surface movement of the sea, so that where the waters of an estuary have any depth, they do not impinge on the bottom, which is consequently unmoved by them. But where the embouchure of a river is comparatively narrow, the space occupied by its mouth forms a quiescent depression, in which every exhausted wave deposits the matter moved by it, and especially when their motion is oblique to the embouchure of the river. A striking example of this is given by the general method adopted on the coast of Sussex to protect embankments from the action of waves, by erecting, at intervals of 200 or 300 feet, fences of boards or branches about 3 feet high on the sloping beach, and at right angles to it. These form the beach into so many troughs or depressions, which retain the shingle so effectually as to become soon buried with it.

It is true that no bars, properly so called, are to be found in the Humber or Thames, but extensive depositions of water-borne materials are made in them. When the volume of water which is discharged from these rivers becomes spread over their estuaries, it is transformed from a rapidly moving current to a quiescent state: then the particles of matter obey the law of their specific gravity, and form extensive shoals of mud, sand, and shingle; but this takes place at some distance from what may properly be considered as the mouths of the rivers. It is quite unnecessary to say more on this subject: all our rivers are examples which enter the sea by estuaries, as the Severn, the Shannon, and a host of others in other parts of the world. I have taken well-known facts for a basis, and endeavoured to chalk out the physical causes of bars in accordance with the great laws of material phenomena, and remain,

Sir, your obedient servant,

W. G.

THE CHINA CLAY OF CORNWALL AND DEVON.

FROM SIR H. T. DE LA BECHE'S REPORT ON THE GEOLOGY OF CORNWALL, DEVON, AND WEST SOMERSET.

THIS substance is prepared artificially in Cornwall and Devon, chiefly from the Hensborough or St. Austell granite, and from the south side of Tregonning Hill in the former, and from the southern granite of Dartmoor, near Cornwood, in the latter. The process is exceedingly simple, and consists in washing the decomposed rock in such a manner, that, by the aid of a succession of tanks, the heavier and useless particles of quartz, schorl, or mica may fall from the water in which they were held mechanically suspended, or forced forward by its velocity; while the finer particles, those composed of the remains of the decomposed felspar, are carried onwards and are allowed quietly to settle in other tanks, where the water being removed, and the sediment partly dried, the latter is conveyed to proper houses, where the drying is completed.

In a district of decomposed granite, such as much of the eastern part of the Austell mass, those places are selected in which the rock contains as little matter except that formed from the decomposed felspar as possible, and where water can be turned on conveniently. The decomposed rock usually contains much quartz, and is exposed on an inclined plane to a fall of a few feet of water, which washes it down to a trench, whence it is conducted to the catch-pits. The quartz and other impure particles are in a great measure contained in the first catch-pit, but there is generally a second, or even a third, in which the grosser are collected, before the water charged with the finer particles of the clay is allowed to rest in the larger tanks or ponds. Here the china clay sediment is allowed to settle, the supernatant water being withdrawn as it becomes clear [by means of plug-holes in the sides of the tank. By repeating this process, the tanks become sufficiently full of clay to be drained of all water, and the clay is allowed to dry so much as to be cut into cubical or prismatic masses of about nine inches or one foot sides, which are carried to a roofed building through which the air can freely pass, and where the cubical or prismatic lumps are so arranged as to be dried completely for the market. When considered properly dry, the outsides of the lumps are carefully scraped, and exported to the potteries, either in bulk or in casks as may be agreed upon.

The clay necessarily varies much in quality; the best has generally been obtained from the neighbourhood of St. Stephens. It appears that 1,757 tons of this clay were exported from Charles'-town to the potteries in 1809, 1,888 tons in 1810, 2,086½ tons in 1811, and 1,252 tons in 1812. Between the 25th March, 1816, and the same day in 1817, 1,775 tons were shipped at the same port for the china manufactories in Worcestershire. It also appears that this export had greatly increased in 1826, for we find that 7,090 tons were shipped from Charles-town in that year for

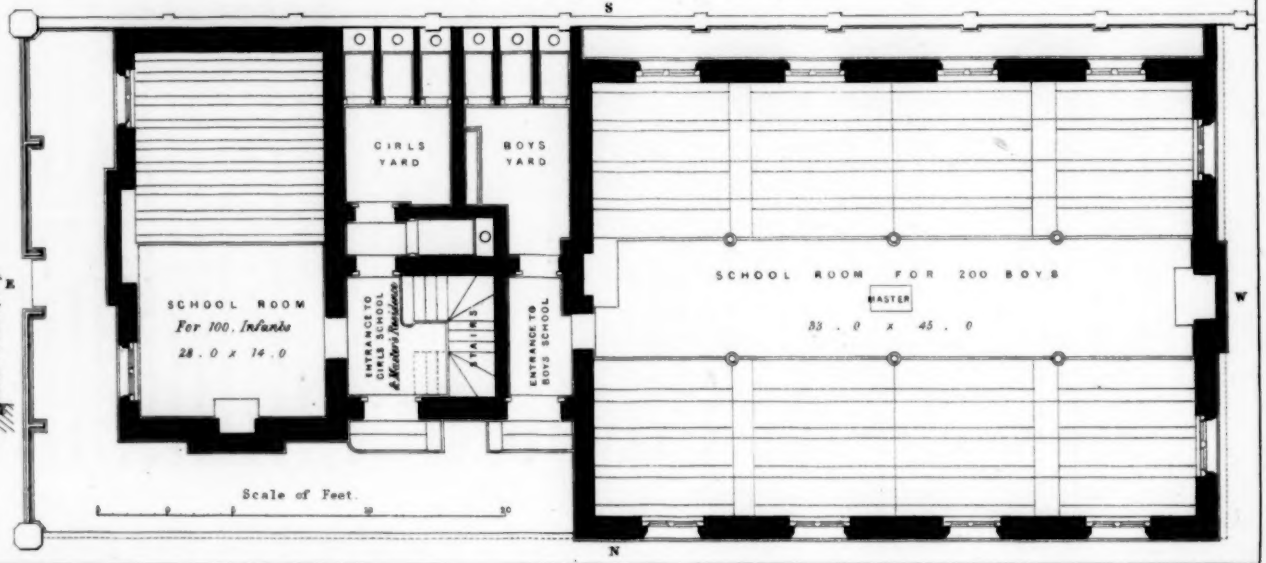
SAINT THOMAS' DISTRICT, STEPNEY. PLAN & ELEVATIONS OF THE NATIONAL AND INFANT SCHOOLS WITH MASTER'S RESIDENCE.

S. STAPLES. ARCHT.

EAST ELEVATION.

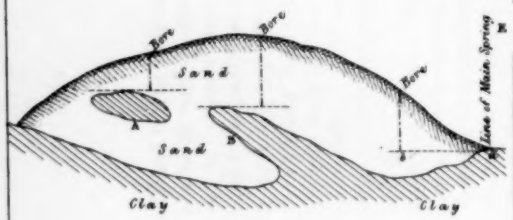
NORTH ELEVATION.

GROUND PLAN.



ARTESIAN WELLS.

Fig 1.



J.E. Millais, J. Warwick, Cr

various places; making, with 400 tons at Pentuan, 30 at Portholeven, and 18 from St. Michael's Mount, 7,538 tons shipped from Cornwall in 1826. If in round numbers the artificial china clay at present exported from Cornwall and Devon were estimated at about 7,600 tons per annum, it would probably be not far wrong.

Independent of this artificial china clay, the district furnishes about 25,000 tons of a natural china clay of inferior quality, from the supracretaceous deposit of Bovey Tracey. This clay, which is stated to have been first worked about the year 1730, is shipped at Teignmouth for the Potteries, and would appear to have been formed naturally much in the same manner as is now done artificially in Cornwall and Devon, though on a larger scale, decomposed granite having been washed down from Dartmoor into a lake or estuary, so that while the grosser particles were first lodged at its higher end, nearest the granite, the fine sediment was accumulated at the lower part. Large quantities of this material have been, and still continue to be raised, from the neighbourhood of Teigngrace and Whiteway, and other places at that side of Bovey Heathfield. The mode of raising it is extremely simple, generally consisting in removing the gravel head, and sinking a large rectangular pit, the sides of which are supported by wood. As the pit is sunk, the workmen, who cut out the clay in cubical or prismatic lumps weighing from about thirty to thirty-five pounds each (of much the same size as those used for artificial clay), fling the pieces by means of a pointed staff from stage to stage according to the depth; after which it is carried to the clay cellars, and thence forwarded when properly dried.

A large vein of steatite in the serpentine was formerly worked for china-making at Gue Grease, near Kynance, in the Lizard district. This is now exhausted as regards its profitable extraction, but it would appear that, about twenty years since, 12 tons of it were annually exported to the china works at Swansea.

Independent of the china clays, about 350 tons of a fine clay are annually shipped from Hayle to the copper works in South Wales. The clay of St. Agnes Beacon is extensively used by the miners to hold their candles, an employment of it, however, which must be somewhat of modern date, inasmuch as both Borlase and Pryce, when noticing this clay, merely state that it had been used for making tobacco-pipes, but that the Pool clays had superseded it.

In addition to the china clay, a semi-decomposed granite of nearly the same composition as the china clay before it is prepared, when the grains of quartz are still disseminated through it, is exported to the Potteries. Indeed, the china clay can be considered as little more than this granite in a more advanced state of decomposition. It is, as Dr. Boase has remarked, composed of quartz, semi-decomposed felspar, and scales of a greenish-yellow talcose substance, requiring nothing more than to be broken into convenient pieces for carriage to be fit for exportation, those parts of a quarry being avoided in which schorl becomes intermixed with the rock. This china stone is chiefly quarried from the granite in the north of St. Stephens, and about 5,000 tons of it are annually exported from Charles Town.

If in round numbers we take the artificial china clay exported from Cornwall and Devon at 7,500 tons, the natural china clay at 25,000 tons, and the china stone at 5,000 tons, we have 37,500 tons of mineral matter annually shipped from the district to the Potteries. It appears that the china clay has been lately (1838) selling for ready money at 1*l.* 12*s.* per ton, and the china stone at 16*s.* per ton; the former in bulk at that price, and without being packed in casks, for which 4*s.* per ton additional are charged. The annual export of the china stone and artificial china clay may therefore be estimated at 16,000*l.*, and if the average cost of the natural clays be taken at only 1*l.* 2*s.* per ton, the value of these various materials would amount to 43,500*l.* annually. This export, considerable as it has become, is of comparatively recent date. Borlase, in his list of clays in 1758, makes no mention of any employed in pottery. He merely notices that of Amalebria in Towednack as likely from some experiments he made to be useful in making porcelain, and states that there were other white clays, such as at Tregonning Hill, near Breague, in the parish of St. Enoder, &c. He must, therefore, have seen those which have been subsequently worked for china clay, though it does not appear that any were then used as such. He states, however, that Mr. Cookworthy of Plymouth had made experiments on the Breague china stone, and that it had been found useful in the making of porcelain. Mr. Cookworthy was the first to manufacture porcelain in England, and Mr. Dillwyn informs us that some of his china made in experimental works is still the most beautiful that has been produced in this country. Pryce, in 1778, states that the public were indebted to Mr. Cookworthy for his late improvements in the porcelain manufactory established at Bristol, which he describes as then likely to rival the best Asiatic china; and he further informs us that the china clay was then made in the parishes of Breague and St. Stephen's by repeated washings with clear water, and afterwards packed in casks and sent off. The artificial making of china clay in Cornwall would thus appear to have commenced between the years 1758 and 1778, and as Mr. Cookworthy, who is mentioned as a person of much talent, was busily engaged during that time in bringing his porcelain manufacture to perfection, we may infer that the first preparation of this clay was due to his exertions.

SAINT THOMAS' DISTRICT NATIONAL SCHOOLS, STEPNEY.

MR. SAMUEL STAPLES, ARCHITECT.

(With a Plate.)

THE necessity of establishing a school in connexion with the Church of England, for the benefit of the labouring classes, in the district of Saint Thomas, Stepney, containing a population of nearly 8,000 persons, and where the proportion of the poorer to the wealthier classes is below the general level, having been long acknowledged, the Rev. W. Valentine, the present incumbent, and a few of the most respectable inhabitants of the district, formed themselves into a committee, and, after several meetings, resolved that a school should be erected, and desired Mr. Samuel Staples, architect, to prepare a set of plans for a master's residence, and school-rooms to accommodate 200 boys, 200 girls, and 100 infants, according to the instructions issued by the Committee of Council on Education in the Report of their Minutes of 1839-40.

It was arranged that the school should be built on a plot of ground thirty-eight feet in length from north to south, and ninety feet deep from east to west, being the south-east corner of the

chapel-yard of Saint Thomas' District Chapel, near Arbour Square, on the north side of the Commercial Road, Stepney. This piece of ground was given by the Worshipful Company of the Mystery of Mercers to trustees for the above purpose. As an entrance to the intended school could only be obtained on the east side, the difficulty of making a design to accommodate so many children on so small a plot of ground was greatly increased.

Mr. Staples' plans having been approved of by the committee, were submitted by him to Her Majesty's Committee of Council on Education for their approbation; and their approval and sanction being given, nine respectable builders were written to for tenders, and that of Messrs. Hill and Son, of Turner Street, Whitechapel, to erect the said school for 1,321*l.*, being the lowest, was accepted. The fittings to the different school-rooms, and a dwarf wall and iron railing on the north side, are not included in the above amount.

On Saturday, October 1st, the ceremony of laying the first stone took place, after divine service was performed in the District Chapel, and an appropriate sermon preached by the Rev. S. Bridge, M.A., evening lecturer of Saint Mary, Islington. The stone was laid by Miss Ward, only child of Thomas Ward, Esq., of Heath House, Stepney, one of the trustees, and a large contributor to the building, in the presence of the Rev. W. Valentine, the present incumbent, (who presented the young lady with a handsome silver trowel, with a suitable inscription engraved on it) many of the neighbouring clergy, and a great number of the most respectable inhabitants of Stepney.

The schools are to be erected with the best hard grey stock bricks, and faced with second malin stocks; the bottom course of footings, four bricks wide, and two feet six inches below the surface of the ground, is laid on a bed of concrete three feet six inches wide, and one foot six inches deep. At six inches above the ground-line a course of slate, well-bedded in cement, is laid throughout the thicknesses of all the walls, to prevent the damp rising. On this course of slate cast-iron air-bricks are fixed, to admit a thorough current of air under the ground-joists. The walls are all worked fair inside for colouring. The casements are of cast-iron; the upper divisions of each open on centre-pins for ventilation. The boys' school-room is forty-five feet long, thirty-three feet wide, and thirteen feet high. The girls' school is over, and is nine inches longer and nine inches wider than the boys', and is ceiled even with the collar-beams of the roof, and thence down the rafters; it is nine feet six inches high to tie-beams, and sixteen feet high in the centre. In the ceiling there are four cast-iron perforated panels, two feet square each, to carry off the foul air. The infant-school is twenty-eight feet long, fourteen feet wide, and thirteen feet high, and above this is a master's residence, consisting of a parlour, kitchen, and two bed-rooms in the roof, fitted up with every requisite accommodation. Circular valvular gratings for admission of fresh air, are inserted in all the floors.

ELECTRICITY—EFFECTS OF LIGHTNING.

BY MARTYN J. ROBERTS, ESQ., F.R.S.E.

TO THE EDITOR.

SIR,

IN your Number for October, a correspondent, "W. G.," has stated in an able manner his opinion on the action of electricity upon buildings. His principal position is, that the disruptive effects of electricity are due *only* to its power of decomposing the materials through which it passes. From this I must differ, for there are many cases in which electricity scatters the particles of bodies that conduct it, notwithstanding these bodies are simple, and therefore not decomposable. For instance, pass a strong discharge from a Leyden jar through a strip of gold leaf; the fragments will be scattered with great force in all directions, and yet here no decomposition can take place, for gold is an uncompounded body. Many similar instances might be adduced, but this, I trust, will suffice to prove that the disruption caused by the passage of electricity is not always due to the decomposition of the conducting body, and therefore that the choice of building materials is of no great moment as a protection from the effects of electrical discharges.

There is no doubt that electric action on air contained in the interstices of a building will cause an explosion, and shatter the strongest walls; but the amount of this effect will not depend upon the quality of the materials in the edifice, but on the quantity of air contained in the interstices that may happen to lie in the track of the electric fluid. A simple experiment will show my meaning. Into the breech of a wooden model of a cannon fix two insulated wires, in such a manner that the two ends (which should be rounded, or terminate in balls) inside the cannon may be about half an inch apart; on these drop a light non-conducting bullet, then pass a strong electric discharge through the wire, and the ball will be driven out of the cannon with great force.

I hold that the best, indeed, the only security to a building from lightning is a good conductor, *of sufficient diameter to convey the current, and perfectly continuous from the summit to the earth; the lower end of the conductor should be in complete connection with the earth.* This is best attained by leading it into a well, or at least sinking it eight or ten feet into the earth, and, if possible, in a wet place. It is also necessary for perfect security that masses of metal or other conducting bodies in the walls of the edifice be connected by metallic strips or rods with the main conductor. It is of great importance that the conductor be perfectly continuous, for accidents have frequently happened in consequence of breaks in the body conducting lightning. I think it would be well to call the attention of those concerned in the repair of St. Martin's church to the requisition I have above stated as essential to the security of a building from lightning.

I differ from W. G. in some of his other positions; but, as they do not directly bear on the question of security to buildings, I will not now enter into a discussion on them.

I am, yours, &c.,

MARTYN J. ROBERTS.

[To the author of the preceding letter the constructive professions are indebted for a process of no less importance than that of blasting by galvanism. We rejoice to see the skill and talents of a gentleman, whose name is identified with so valuable an application of science, directed to the subject of preserving buildings from destruction by lightning; and whether his extensive experience may serve to confirm or to dispute the conclusions of our correspondent, W. G., it is certain that practical good must result from a discussion between those whose opinions are so well entitled to respect and consideration.—ED.]

DREDGE'S SUSPENSION BRIDGE.

In acknowledging the receipt of a communication from Mr. Dredge, the author of a new and highly ingenious principle of building chain bridges, we take the opportunity of expressing our gratification at the progress he is making in public estimation. We have heard it hinted in various quarters, that many engineers and architects are prejudiced against the system, and the main reason we have heard assigned for this prejudice is, because its inventor is not one of themselves, namely, neither an engineer, nor an architect, and therefore any improvement which he may profess to have made in such a subject as bridge building, is unworthy of any attention, and deserves only ridicule and contempt at the hands of professional men. So much for the liberality and toleration of spirit by which some members of the constructive professions are distinguished; while on the other hand, there are others—and we need not pause to show which line of conduct is the most admirable or worthy of respect—who will look at the invention of Mr. Dredge in a cool spirit of impartial justice, and will at least take the trouble to understand it, and adopt the absolutely necessary means for arriving at a correct judgment, before they venture blindly and rashly to condemn. The best comment on the little, paltry spirit of the other class is, that Mr. Dredge, amid the showers of their abuse, the venom of their envy, and the pompous vapouring of their professional dignity, is all the time carrying forward his views with almost uninterrupted success, in one place ranking a high official department of the government as his patrons and employers, and far and wide raising up friends and advocates amongst the most powerful, intelligent, and public-spirited of our native landed proprietors. The five bridges which Mr. Dredge has erected in the Regent's Park for the Commissioners of Woods and Forests, at intervals of time sufficient to test the value of the principle, attest the opinion entertained of his improvements in that quarter, and the powerful advocacy with which Lord Western addressed the prime minister in 1840, on the subject of these bridges, and the subsequent employment of Mr. Dredge to erect an extensive bridge for Sir James Colquhoun, in Scotland, another for H. Miller, Esq., of Frome, and another for G. S. Harcourt, Esq., at Wraysbury, near Windsor, exhibit in a convincing manner the gradual and certain progress of a highly favourable opinion in the minds of the public.

The Victoria bridge, erected by Mr. Dredge, across the Avon, at Bath, is 150 feet in span; that for Sir James Colquhoun, across the Leven, at Loch Lomond, is 294 feet in span, and 20 feet in width; and the one just completed for G. S. Harcourt, Esq., at Wraysbury, is 100 feet in span, and seventeen feet wide, and is intended for every description of traffic. Mr. Dredge informs us in the communication referred to, that he has erected seven bridges within the last thirteen months, and such is the rapidity with which these bridges can be put together, that Mr. Dredge assures us the bridge at Wraysbury was entirely completed in three weeks from the time the foundation stone was laid.

Various accounts of Mr. Dredge's principle, with drawings of two of those erected in the Regent's Park, have appeared in this Journal during the last twelve months, from which, in a general way, they may be very well understood; but we hope shortly to lay before our readers an actual working drawing of one, showing the whole detail of its construction.

Mr. Somerset Irvine, of Liege, has given some excellent illustrations of the principle adopted in Mr. Dredge's bridge. He observes, that cones and pyramids are well known to be stronger forms than cylinders and prisms on the same base, and of the same height, and he remarks that this principle, so incontestably true for vertical bodies, ceases not to be true when the same body is in a horizontal position. In order that the principle may obtain, however, it is necessary that the horizontal beam be fixed at one end, and this being done, it is perfectly well known that a pyramidal or wedge-shaped form is equally strong with a rectangular bar. Of course, when a beam is supported at both ends, the rectangular form is stronger than that made by hollowing out either the upper or under side of the beam. But the comparison, in the case of Mr. Dredge's bridge, is to be made with a beam immovably fixed at one end, under which circumstances the tapering form is evidently endowed under certain limits with the same strength as the rectangular. On account of the system of diagonal suspension rods, Mr. Dredge's bridge is exactly in the position of an inflexible beam, firmly fixed at one end; and there is this remarkable difference between his and the common suspension bridge, that if it were cut in two halves by a line across the roadway, each half of the bridge would still stand by virtue of its peculiar principle of suspension, and of the consequent rigidity and beam-like form of the whole structure, whereas the old suspension bridge thus divided in two would immediately fall in complete ruin. This distinction is of considerable importance, not only in relation to the comparative resistance opposed by the two kinds of bridge to the destruction of storms and other violence, but also because it exhibits the adaptation of Mr. Dredge's bridge to certain localities where the ordinary bridge would be practicable only at an immense expense. We allude to cases where a bridge has to be constructed over a hollow in which a roadway changes its direction in the hollow itself. Take, for example, the well-known Holborn Hill, where, owing to the angle formed in the hollow, Mr. Dredge's bridge is the only one which could be constructed across the valley by means of a single central pier. A bridge on his principle might there be erected at far less expense than any other kind at present known, and occasion less interference with the existing traffic.

It is true we have not yet much experience of the effect produced on Dredge's bridges by a heavy general traffic, as the bridges in the Regent's Park, although several are of considerable span, are only used as foot-bridges for passengers. The weight they sustain is thus probably greater than if they were used for wheeled carriages, but the kind of vibration produced by the traffic is different. However, as the bridge at Wraysbury is intended for general traffic, experience on this point will not long be wanting.

Mr. Dredge states that the comparative expense of his bridges with those on the old suspension principle, is one half for a 50 feet span; one third for 100 feet span; that five of his bridges of 200 feet span might be built for the cost of one on the old principle; seven for one of 400 feet span; and fourteen of his for one of the other, when the span is 800 feet. This is not idle boasting, as we presume that Mr. Dredge is himself ready to undertake the construction of any number of bridges on these terms.

ON THE MEANS OF PURIFYING WATER,

COMMUNICATED IN A LETTER TO THE EDITOR, BY GEORGE WHITE, ESQ., CIVIL ENGINEER.

NOTWITHSTANDING the numerous plans which have been proposed at various times for supplying the metropolis with pure and wholesome water, I cannot help expressing my regret at seeing them so readily forgotten, without apparently a single experiment on the large scale to test their efficacy. It is needless to remark, that nothing is more necessary for the preservation of health than a pure and sufficient supply of good and wholesome water, and it is mainly to be attributed to an impure supply that mortality and disease increase so rapidly. The Thames, which is the chief source of supply to the metropolis, contains large quantities of both mechanical and chemical impurities, chiefly owing to the different drains and sewers being emptied into it, and it is much to be regretted that this class of nuisances has not been obviated. The absorbing wells in Paris for this purpose have given very general satisfaction, and from the experience they have already had, appear to answer uncommonly well.

I believe that some of the companies have commenced filtering water by allowing it to pass through a layer of coarse sand and gravel, but I cannot help expressing my opinion, that however effectual this mode may be for making the water clear and transparent, yet it obviously is not adapted for depriving water of any taint which it may have acquired from the putrefaction of animal or vegetable matter. This object can only be attained by allowing water to filter through some substance of a purifying nature, such as charcoal, the great preserving properties of which have long been established. The use of charcoal has been introduced for some time at the filtering establishment at the eastern end of Paris, for filtering the waters of the Seine. The water, after undergoing this process, has given the most general satisfaction, and as this mode appears to be particularly applicable to the Thames, it may be useful to lay before your readers a slight sketch of the plan there adopted.

The water is pumped up from the eastern part of Paris before it enters the metropolis, after which it is allowed to subside for twenty-four hours, by which means it has time to deposit the large quantities of muddy sediment; the water is then ready for being turned into the large leaden cisterns which are prepared to receive it; they are filled with sand, charcoal, and coarse gravel (the latter being on the top,) to the height of about two feet. The water, in passing through the gravel, loses a large portion of sediment which was too fine to be deposited by mere subsidence; it then comes in contact with the charcoal, which readily takes away any taint or impurity, that cannot be separated by filtration through other substances. The water finally passes through the stratum of finely pulverized sandstone, which gives it a clear and crystaline appearance, so very desirable for water used for domestic purposes. Our informant states that he has examined the water after passing through each layer, and that the change which takes place is very great indeed. We cannot conclude this short sketch without taking notice of the plan lately patented by Professor Clark, of Aberdeen, for rendering various waters pure and fit for domestic purposes, the Thames being amongst the number. He shows, in a very interesting pamphlet lately published by him onthe subject, that the Thames holds large quantities of chalk in solution, which however, is perfectly colourless and transparent. To understand the process, it will be necessary to premise that chalk cannot be dissolved in water unless it is either deprived of a certain quantity of carbonic acid, or unless it is overcharged with carbonic acid. Thus, a pound of chalk will not be soluble in water until it is deprived of its seven ounces of carbonic acid, after which it can readily be dissolved in forty gallons of water; also, a pound of chalk, with seven ounces additional of carbonic acid, can readily be dissolved in 560 gallons of water. The process, therefore, almost suggests itself: the 40 gallons of lime water must be mixed with the 560 gallons of water holding bicarbonate of lime in solution, when the lime which has no carbonic acid will naturally deprive the bicarbonate of seven ounces of carbonic acid, in which case both pounds of lime or chalk will contain seven ounces of carbonic acid, under which circumstances it is insoluble, as before stated.

AGRICULTURING ENGINEERING—IMPROVEMENT OF WASTE LANDS.

TO THE EDITOR.

SIR,

As you did me the favour to insert in your Journal of last month my letter on the drainage and cultivation of waste land, I proceed to fulfil my promise of recurring again to the subject. In my former communication I pointed generally to the Highlands of Scotland as an example of what industry and perseverance had done to render the most impoverished soils and barren wastes profitable and luxuriant. To enumerate each particular locality where these examples are to be found, would be to mention almost every glen and hill side throughout the Highlands, for, since the primary step of making roads and perfecting the communication between one district and another has been effected, the improvements have progressed with a rapidity truly surprising. I propose, however, to select one or two of the most striking instances where improvement has been most extensive, a description of which will perhaps be found interesting to the general reader. And to begin with the coast road from Aberdeen to Inverness.—Travelling through that district thirty years ago, the principal features of the country which met the gaze of the traveller, were mountains bleak, barren, and exposed, down whose sides the sparkling rivulet dashed in its onward course towards the sea, and vast moors of uncultivated land, where, far as the eye reached, no vegetation could be traced but the hardy gorse and whin, with here and there, at long intervals, a small patch of green sward—an oasis in the desert—with a diminutive black dreary-looking hut in the centre, around which pastured a few sheep, as miserable and poor in appearance as the country which they inhabited was bleak and unpromising. If the traveller wandered towards the sea-coast, the country, though it presented a different aspect, was equally barren and unfruitful as that which I have described, exhibiting nothing but a sterile waste of sand, interspersed with patches of moorland and peat. In passing through the same country two years ago, I was agreeably surprised to witness the improvements which labour had effected upon these lands. The barren heaths were transformed into thriving and luxuriant farms, with comfortable stone-built dwellings and homesteads. Other parts of the waste had been converted into large forests of fir timber;—in almost all of which great activity prevailed in preparing the timber for exportation and home use.

To effect this desirable change from the sandy and most sterile districts, where nothing but the whin bush and the heather grew, the following is, I understand, the general method of procedure:—the whins and heath are first rooted up and burned; the ashes are carefully preserved and mixed with the poor peaty soil, on which the patches of heather were found to grow; this is spread on the sand, and here the seedling firs are planted. These seedlings readily take root, and as they grow they form a soil for themselves by the successive deposit of the leaves. So rapid is the growth of the fir in these soils, that, after the first three or four years, they require constant periodical thinnings. The produce of the first thinnings is only fit for firewood and slight fencing; but it soon becomes valuable for prop-wood, which is sent in great quantities to Newcastle and the mining districts. In the course of thirty years, the timber is generally cut, when many of the trees are found to contain from ten to twenty cubic feet of timber. The whole forest is then cleared, with the exception of a few slight beltings left standing, which serve the double purpose of ornament and shelter to the unprotected land which has just been cleared. The process of converting that which was lately a forest into arable land then commences. The roots being grubbed up, the surface will be found to consist of a light soil, several inches in depth, formed, as I have already observed, by the successive deposit of the leaves. Without admixture this soil would be found too light for farming purposes; it is therefore necessary to mix it with a material less absorbent, and it is considered a fortunate circumstance if clay can be procured within a reasonable distance to incorporate with it. If near the sea coast, a compost of clay, sea wear, and lime is mixed with it, until it becomes sufficiently retentive. Where sea wear cannot be procured, farm manure is used, which answers the same purpose; but in that country such manure is expensive, and not easily obtained. The industry and perseverance with which the farmer strives to procure a suitable covering for the light soil is truly astonishing and praiseworthy. He clears ditches where mud has been deposited; he scrapes the roads; he collects decayed vegetable and animal matter of every description; he watches the ebbing of the tide to collect the wear, and indeed neglects no opportunity of adding something to his "middings," as he terms the heaps of manure which at certain seasons may be seen scattered over the land. The soil being thus improved, the land is ploughed, and the seed deposited in the usual way. The first crop is generally oats or barley; and, however scarce the manure may be, in the course of two or three years the finest crops of every description are produced. Their barley and turnips struck me as being equal, if not superior, to any I had seen in the southern counties of England.

The method of cultivating the heathy parts of the country on the hill sides is more simple; it being only necessary to construct a few catch-water drains, grub up the heather and strip off the surface, burn them, and mix the ashes with a portion of sand, clay, or lime, and as much manure as can be procured. This mixture is spread equally over the surface, and the land is then ready for the plough. This soil, although at first of very inconsiderable depth, is exceedingly productive, and excellent crops are soon procured.

The next description of land of which I come to speak, is the swampy and boggy lands, which for their improvement depend principally upon effectual drainage and the due admixture of other soils, determined by the nature of the original; if such be of a retentive and clayey nature, it is intermixed with a peaty, sandy, or gravelly soil, and *vice versâ*. Having had an opportunity of witnessing an operation in Inverness-shire in the Highlands of Scotland, which was simple, exceedingly successful, and, to me, quite novel, I do not hesitate to present a description of it to your readers. The piece of land operated upon was of an oblong shape, containing about five Scotch acres, and was of a very swampy character. It was situated between two hills, having an outlet at each end. The first process was to fetch up a dead level from a neighbouring brook by cutting a drain from it right through the centre of the swampy ground; this drain was three feet wide at bottom, from three to four feet deep, and about ten or twelve feet wide at the top. This operation was performed in the month of May, and in the following August the land was nearly dry; it was, however, yet quite unfit for the plough. Collateral drains were then cut from the main drain at intervals of five or six yards, and at right angles to the main drain, extending on each side to the rising ground. These drains were also about three or four feet deep, but not more than eighteen inches wide at bottom, and from three to four feet wide at top. The land remained in this state until May of the next year, when the various beds intersected by the transverse drains were found to be perfectly dry. The farmer then commenced the second part of his operations: he stripped off the surface to the depth of about two inches, and carefully laying it one side, the land was dug over with a spade. Regular rows of potato sets were laid upon the surface; over the potatoes was placed a slight sprinkling of an indifferent quality of manure, consisting chiefly of ashes, straw, and decayed vegetables; on this again was laid the surface covering which had been preserved, with the grass downwards, and above all was spread the stuff which had been excavated from the drains. This done, the whole swamp presented the appearance of alternate beds and drains; and it was with no inconsiderable curiosity that I watched for the appearance of the crop. In due time the potatoes made their appearance, and after the usual processes of hoeing and weeding had been performed, the crop was found to be prolific, and of excellent quality. In the course of the next year, as many of the transverse drains as it was thought necessary to preserve for the future drainage were filled to within eighteen inches of the top with brushwood and stones. The land was then levelled so as to fill the remaining eighteen inches of these drains, and to fill entirely the unnecessary drains, so that the whole now presented the appearance of a tolerably-sized field, with an open drain through the centre. I had an opportunity of visiting this part of the country several years afterwards, when this very piece of land was under a crop of barley, and a more luxuriant or finer crop could no where be met with. Although the drainage part of this system may be considered somewhat expensive, it should be recollected that the plan proved quite effectual, and that the very first season a profitable crop was produced which more than covered the outlay, and that henceforth the land was fitted for the reception of general crops.

I shall, with your permission, Mr. Editor, resume the subject at a future opportunity, and

I am, Sir, your most obedient servant,

A Friend to all Improvements.

London, Oct. 20, 1842.

THE WEST COAST OF AFRICA.

We extract the following observations from a Report made in September, 1841, by Dr. Madden, Her Majesty's Commissioner, on the State of the British Settlements on the Western Coast of Africa. This Report has just been printed, with other papers, by order of the Houses of Parliament.

Dr. Madden's observations will be interesting at this time, in consequence of a recent attempt at systematic colonization in that country, and which project is said to be not yet abandoned. As engineers and surveyors must henceforth play a prominent part in all projects of this kind undertaken with any chance of success, official and scientific information relative to the climate and the natural history of the country cannot fail to be alike interesting and useful to those who entertain any idea of exchanging their own for a foreign field of action.

OBSERVATIONS ON PROFESSOR DANIELL'S REPORT ON THE WATERS OF THE COAST OF AFRICA, AND THE CAUSES OF DISEASES IN TROPICAL CLIMATES, ADDRESSED TO SIR JOHN BARROW IN 1840.

The waters examined and analyzed were the following:—
The Sierra Leone River, three miles from the mouth.
The Rio Volta River, twenty-eight miles from the mouth.
The Bonny River, at the mouth.
Mooney, at Corisco Bay.
Gaboon River, eight miles up.
Cape Lopez Bay, ten miles off Cape.
Congo, mouth.

The Professor, in speaking of the results of this analysis, states, that "the most remarkable circumstance disclosed by the analysis of these waters is a strong impregnation of the majority of them with sulphuretted hydrogen, which, as in the case of the water from Lopez Bay, amounts to almost as much per gallon as the Harrowgate waters. The proportions of the saline particles do not vary materially from those which are usually found in sea water." He goes on to state of this gas, that "its effects on the copper sheathing of ships cannot fail to be highly injurious, and a question of still higher importance arises, whether this deleterious gas may not contribute to the well-known unhealthiness of the coast from which these waters are taken." Having examined the copper taken from one of our cruisers that had been on the western coast of Africa station, Mr. Daniell says the copper was in a very bad state, and partly eaten into holes, and covered with two crusts, the external one green, and the inner one black; and connecting these results with those previously obtained from the analysis of the waters on the coast of Africa, he continues: "I have no doubt that the injury to the copper has arisen primarily from the sulphuretted hydrogen." This deleterious gas, the Professor states, "has been proved to impregnate the waters upon the western coast of Africa in such enormous quantities through an extent of more than sixteen degrees."

He says there are only two sources to which it can be with any probability referred, namely, submarine volcanic action, and the reaction of vegetable matter upon the saline contents of the water. To the last source he attributes the evolution of the sulphuretted hydrogen in these waters, to whose existence he refers the unhealthiness which prevails on these coasts. "Of its formation," he says, "what is known of the action of vegetable matter upon sulphates, and the immense quantity of vegetable matter which must be brought by the rivers within the influence of the saline matter of the sea, renders this second origin extremely probable. Decaying vegetable matter attracts the oxygen from the sulphate of soda, and a sulphuret of sodium is formed; this again, acting upon water, decomposes it, and sulphuretted hydrogen is one of the products of the decomposition. As to the deleteriousness of the sulphuretted hydrogen, he states, "It has been found that so small a mixture of it as a fifteen hundredth part acts as a direct poison upon small animals."

The peculiar unhealthiness of mangrove swamps in all parts of the world, he states he has little doubt arises from that tree requiring salt water for its growth, and its decaying foliage being thus brought into immediate contact with the sulphates.

The hypothesis also agrees with the fact which he believes to be established, that the unhealthiness of such situations does not extend to any considerable distance from the sea. The practical object that is attempted to be established by the foregoing theory is, that the avoidance of malaria on the western coast of Africa is to be attained by not lingering in situations where the water affords indications of the noxious gas; that such indications are to be obtained by testing the water with sulphate of copper: that "it can extend but a small distance up the rivers;" and that in all situations where this malaria exists, the danger is to be obviated or mitigated by the copious fumigation with chlorine, generated from common salt, manganese, and sulphuric acid, as the contact of chlorine with sulphuretted hydrogen instantly effects its decomposition. He also recommends that "particular attention should be paid to the state of the bilge-water in the vessels on this coast, and has little doubt that the bad smell in the holds of ships is often owing to the generation of sulphuretted hydrogen, by the same kind of reaction between vegetable matter and the sulphate of soda in sea water." None of the waters tested by Professor Daniell was taken very high up in the rivers. Now the mixture of salt and fresh water he thinks essential to the generation of this gas; therefore, where the tide does not reach, and where the mangrove growth ceases, we ought to be safe from the fever that is so fatal on the coast; but is this the case? The mortality in the interior of Africa from fever and dysentery, I doubt very much if it would be at all smaller among Europeans than on the coast. The greatest mortality that has occurred in the expeditions that have been sent into Africa has been high up in the country, and frequently hundreds of miles from the coast. In Park's second expedition, of forty-four Europeans who accompanied him from the Gambia, thirty-nine died between Shrouda and Sansanding, several hundred miles distant from the mangrove swamps of the Gambia, through which they had passed without loss. In Park's words, "the beginning of sorrow was at Shrouda."

In Messrs. Laird and Oldfield's expedition up the Niger in 1833-4, of the united crews of the two steamers, namely, forty-eight individuals, but nine returned: the majority died in the upper country, near Damuggoo.

In Captain Tuckey's expedition in 1816 to the Congo, there were fifty-six deaths of Europeans. At the highest point reached by the expedition, the sickness was greatest, namely, two hundred and eighty miles from the coast.

At the Gambia the mangrove extended up the river as far as Cowar, about one hundred miles up. It seems as if the salt or brackish water was essential to its growth, for it certainly does

not abound where the water is entirely fresh. But its absence is no proof of the healthiness of the bank of a river. On the Senegal, for instance, there is very little mangrove, and yet fever and dysentery especially prevailed there. Neither brackish water nor mangrove extends to Pisania, yet here Park himself suffered most severely from fever.

The lieutenant-governor of the Gambia, in the year 1840, having taken the opinion of Dr. Brunton and some other gentlemen at the Gambia, was induced to believe, that by opening the great sluice on the island, and allowing the sea water to overflow the land and mingle with the stagnant fresh water that had lodged in the dykes, the healthiness of the place might be improved; and the experiment was accordingly made, allowing the sea water to overflow the streets, even in some quarters to the doors of the houses, and he is not aware that any sensible effect was produced on the health of the inhabitants. But though there were not fewer cases of fever in the bad season, the disease was of a much milder form, and less fatal than usual. A contrary result might have been expected if the generation of sulphuretted hydrogen, supposed to be so prejudicial to life, were to be effected by the mixture of waters in such a locality, a perfect mangrove swamp, formed by the accumulation of fresh and salt water.

Professor Daniell quotes some observations of Signor Giorgone, on a marshy district on the shores of the Mediterranean: "The mixture," he says, "of fresh and salt water thus formed, and which in summer was rarely changed, became corrupt, and spread infection over the neighbourhood of the most destructive kind; one single night caused death to the incautious traveller who should stay so long in this infected country."

Such was the state of things till a sluice, which excluded the salt water, was constructed at the mouth of the Burlamacca, and the most complete success was the consequence, and all its insalubrity has disappeared. Several other places in Italy, where the same steps have been taken, have been attended with the same happy results.

Upon the latter observations, as to the efficacy of preventing the mixture of sea and fresh water in confined situations, I have not the slightest doubt. In the port of the Havana, and in that of Matanzas, in the island of Cuba, my attention was first called to the offensiveness of the smell of these places far in shore, at the bottom of the harbour, either before sunrise, or after sunset, especially in calm weather. In both of these places, where the harbour forms a *cul de sac* towards its extreme distance from the coast, there are streams of fresh water; at Matanzas, indeed, considerable rivers. At Havana, where the stream of fresh water enters the harbour below the arsenal, I have perceived, on an oar accidentally touching the bottom in the shallow parts, that an effluvia so intolerably sickening and offensive arose, as to produce a sense of faintness and nausea. The circumstance I allude to happened in the evening; and precisely the same accidental stirring up of the slime in the harbour of Matanzas, shortly after sunrise, close to the mouth of one of the rivers in the port, produced the same peculiar, offensive, loathsome, deadly odour, which cannot be described except as being the concentrated stench of decayed vegetable matter, loaded with malaria. In Sierra Leone, likewise, at a place called King Tom's Point, in front of the Kroo Town, the stench that arises from the shallow water close to the beach, early in the morning and late in the evening, is intolerable, and I am told the same is observable in the lagoon, in the vicinity of Cape-coast Castle.

With respect to that part of Professor Daniell's observations on the existence of sulphuretted hydrogen in the waters of the African rivers, in quantities to be deleterious to health, and to be esteemed one of the chief causes of the activity of the malaria virus on the western coast of Africa, the period of these observations falling into my hands prevented me from testing the waters of the rivers he has named, and of ascertaining on the spot whether sulphuretted hydrogen abounds in them or not. But my belief is, that the sulphuretted hydrogen which Professor Daniell found in these waters in England, had been the result of the alterations which the waters had undergone during the time of their conveyance to England. With respect to fresh water, there can be no finer water in any country than at Sierra Leone and Prince's Island, yet both places are most inimical to European health; and there is no appreciable difference in the taste or smell of these waters from those of the purest springs in England. These waters are not impregnated with sulphuretted hydrogen, like the waters of Harrowgate, the presence of which in the latter is surely cognizable enough to the sense of taste and smell. The following circumstance throws some light, I think, on the subject of the supposed existence of this gas in the African rivers, transmitted to England for analysis:—

In the month of January last, a friend of mine, who was aware that I was not in the habit of drinking wine or spirits, thinking it would be advantageous for me to have pure water in those places where I was then going to, and whose unhealthiness had been ascribed by some to the impurity of the water on the coast, had sent me two barrels of water, taken from a spring rather celebrated for the purity of its water, called St. John's Well, on the property of a gentleman in his neighbourhood. Great care was taken in the preparation and filling of the casks, and I took them with me to Cape-coast Castle. There, on opening a vent in one of the casks, to my great surprise and disappointment, the effluvium that escaped of sulphuretted hydrogen was intolerable. In plain terms, the smell was that of rotten eggs, and the colour nearly as black as that of water in which a brush had been dipped with Indian ink. I then examined the other barrel, and the result was similar. I had the bungs taken out, and again examined the water in four or five days' time, and it had undergone no improvement. Had this been river water, probably the salts suspended in it would have prevented this complete decomposition, and so large an evolution of sulphuretted hydrogen, and have occasioned a second fermentation, which would have tended to its ultimate purification; and probably in the African rivers there is a smaller quantity of these salts dissolved than in those of Europe, and are not sufficient to prevent decomposition on the voyage to England, or to effect its subsequent purification. If it be so, the presence of the sulphuretted hydrogen in the small quantities of the various waters presented to Professor Daniell for analysis, is easily accounted for, and the theory that is built upon this hypothesis must be received with caution, in order that the lives of men may not be risked on the opinion that the jungle fever of Africa is confined to the rivers or sea coasts of that country, and that by avoiding these they may escape the perils of the climate.

These perils, in my opinion, are occasioned by atmospheric conditions and circumstances connected with vegetation, and not by peculiarities in the waters of these countries. The fever of Africa is not confined to swamps or marshes; it has been found as deadly to European troops in Accra, where there are no swamps or marshes in the vicinity, as at Cape-coast, where lagoons exist in its neighbourhood. In a word, wherever there is a hot and humid

atmosphere, and an uncultivated country, with a rich soil, and a rank, rapid vegetation, there the elements of African disease are to be found, and there also its perils are to be avoided.

ASPHALTIC OR BITUMINOUS CEMENTS.

THE value of asphalte is not sufficiently appreciated by the engineers and architects of this country. For some account of its successful application to the purpose of preventing damp from rising in the walls of houses, we refer our readers to a communication by M. Janniard in the number of the Journal for last month. The method used by this architect is that of interposing at the surface of the ground a layer of the asphalte, about three inches in thickness, between two courses of the stone or brick-work. It would probably answer equally well to set three or four of the courses in the asphalte, using it as a cement in place of lime mortar.

All the asphaltes, whether resinous or bituminous, and whether natural or artificial combinations, are repellents of moisture, and are perfectly insoluble in water. There is considerable difference, however, in their adhesive properties, that is, in their strength as cements, and in their capacity of resisting the action of the sun and frost.

The bituminous asphalte consists of pounded chalk or other lime-stone, mixed with bitumen, pitch, or tar; and the resinous asphaltes consist of pounded chalk or limestone mixed with resin.

The resinous kind appears to be the strongest as a cement, but it may possibly be more easily softened by a warm sun. All the kinds of asphalte are improved by the addition of sand or pounded sandstone; and we have seen specimens of resinous asphalte which, after being melted up and mixed with twice its weight of sharp sand, and poured into moulds, hardened into a mass, which possessed all the hardness and apparent durability of first-rate stone. It could be dressed with the chisel, rubbed to a fine surface, or sawed into any form required, and we have ever since been astonished that no individual or company has ever undertaken on an extensive scale the manufacture of this artificial stone. From numerous experiments made upon a resinous asphalte as a cement, it was found to possess far greater strength than the best Roman cement. Among the variety of uses to which this substance may be applied, we may mention all kinds of floors and pavements, except those subjected to great heat—the covering of arches, viaducts, bridges, cellars, and the lining of all kinds of roofs and drains where it is desirable to keep the water from penetrating,—grave-stones with sunk letters, sink-stones, small troughs, and numerous utensils required to hold water without the possibility of leakage, might be formed by casting the liquid cement into moulds. Another very important use, however, is deserving of particular notice, namely, the substitution of these cements in place of lead for fixing iron railings. Few persons possessing the least faculty of observation can have failed to observe, in passing through the streets of the metropolis, or of any other large town, the rapid destruction of the iron and lead at the base of every iron railing along the line where it is fixed to the stone plinth. This destruction has been attributed to a galvanic action between the iron and the lead, which tends rapidly to their decomposition, and is further aided by the oxidation of the iron. Now if asphalte were used instead of lead, the fixing will be in every respect as secure, and it will at the same time be absolutely incapable of injury by moisture. In the strong and massive railing which surrounds the churchyard of St. Martin's at Charing Cross, the railing is fixed with a resinous asphalte mixed with sand, in consequence, it was said, of the contractor's inability to employ a material so expensive as lead. The specification had omitted to direct the employment of lead, and although the architect objected to the new expedient, the contractor persisted in fixing the railing in his own way, defying any one to show that it was not erected in a substantial and workmanlike manner. Experience has now fully proved that he was right, as nothing can be more satisfactory than the appearance of the work, not the slightest trace of decomposition or decay being visible at any of the points where the asphalte has been used.

It should be observed, that asphalte, when united with sand, is much improved for most purposes, because its hardness is increased, and it is rendered more capable of resisting heat. A notion that its employment in houses would be dangerous, on account of the fuel it would furnish in case of fire, has been entertained by some, but has been found to be entirely without foundation; because, particularly when mixed with sand, the cement is very thick when melted, and if poured on a flame in this state serves rather to extinguish or to check it than to favour its progress.

All those cements which can be melted by heat, and which are insoluble in water, can be readily dissolved in spirits of wine, and even in the ordinary spirituous liquors of commerce.

SPECIFICATION OF A DOCK,

WITH A SEA ENTRANCE, STOP GATES, &c., CONSTRUCTED FOR THE LLANGENNECH COAL COMPANY, AT LLANELLY.

THE dock is to be made at the extremity of the proposed railroad, to be 615 feet long from the head-wall of the dock to the entrance, and 166 feet wide from the wall to the bank at the level of high-water mark.

The whole of the ground forming the area of the dock entrance is to be excavated to the under-mentioned depths. The bottom of the dock is to be excavated to the depth of 20 feet below the level of high-water mark, and of a sufficient length and width, having proper slopes, so as to enable the walls and entrance to be built. The ground for the stop gate entrance, walls, and chamber is to be excavated to the depth of 24 feet below the level of the above-mentioned high-water mark.

The foundation for the retaining walls is to be excavated to the depth of two feet below the bottom of the dock, and of a sufficient depth behind to allow for the radiation of the wall. The bank opposite the retaining wall is to have slopes of two feet horizontal to one foot perpendicular, and to be neatly trimmed off when the works are completed. The whole of the ground excavated out of the proposed dock and entrance is to be used to bank up the retaining and entrance walls as hereafter described. A channel is to be excavated for the proposed entrance to the dock to low-water mark; it is to be excavated to a depth of 21 feet below high-water mark, and to be deepened at its extremity 1 foot, making 22 feet below high-water mark. The whole of the ground excavated out

of this channel is to be formed into jetty banks—one bank is to be made on each side of the entrance. These slopes are to be 200 yards long each, having slopes of at least 2½ feet horizontal to 1 perpendicular. These jetty banks are to be solidly formed by laying the ground in regular layers of about 9 inches or 1 foot each. Each layer is to be well chopped and beat together, so as to be made as solid and compact as possible. When these banks have been formed to the requisite heights above the level of high-water mark, and have become sufficiently solid, their slopes are to be faced with copper slags, which are to be well beat in. The retaining walls and counterforts round the dock are to have a puddle of clay and gravel 4 feet wide formed behind them, mixed in the proportion of two-thirds of clay to one-third of gravel, which is to be brought up to within 1 foot of the top of the wall. This puddle is to be backed up with earth laid in layers of about nine inches each, which is to be well chopped and trodden together. The bank at the back of the wall is to be made as wide as the quantity of ground taken out will permit, to be made up to the level of the top of the coping, and to have slopes of at least 2½ feet horizontal to 1 foot perpendicular. The wing and chamber walls of the entrance are to have a puddle of clay and gravel 5 feet wide made behind them, and to be backed up in equal layers with earth or quarry rubbish. The whole of the foundations are to be properly levelled, and the whole of the water is to be removed that may interfere with the works. The foundations are to be kept perfectly dry, so as to enable the work to be properly performed. The person undertaking the works is to find all pumps, troughs, engines, &c., that may be required to remove the water, and make all dams, stanks, &c., and remove the same when done with. The slopes of the banks at the back of the quay wall are to be faced with copper slag, which is to be well rammed in. An outlet is to be excavated for the river Daven of sufficient capacity to let off the water, having a culvert made through the banks, and a hanging valve at the outlet.

The stop gate entrance is to be made 30 feet wide between the coping, and 60 feet long across the pier, and 24 feet deep from the pointing sill to the top of the coping. The foundation of the entrance is to be formed upon bearing piles and sheeting piles, which are to be driven as hereafter described. When the whole space has been excavated to the requisite depths, a row of beech, elm, or fir, grooved and tongued sheeting piles, 6 inches thick and 12 feet long, are to be driven at each end of the inverts, and 10 feet long at each side. These piles are to be properly prepared, and shod with wrought-iron shoes weighing 12 lb. each, and hooped with wrought-iron hoops, to prevent them from splitting whilst driving; and they are to be driven within one foot of their whole length into the ground. One hundred and twenty beech, fir, and elm bearing piles are to be driven between these sheeting piles, to support the superstructure; each bearing pile is to be driven from 12 to 15 feet into the solid ground; and each pile is to average from 9 to 12 inches diameter in the middle. The whole are to be properly prepared and shod with shoes weighing from 10 to 12 lb. each, and hooped with wrought-iron hoops, to prevent them from splitting whilst driving. When the whole of these piles have been properly driven, their heads are to be levelled, and beech, fir, and elm sleepers, 10 inches square, are to be well jag-spiked down to the pile heads. The ground will require to be excavated for these sleepers at the time they are being fixed. When these sleepers have been properly fixed, cross sills 10 inches square are to be well fitted and jag-bolted thereto. The spaces between the sills are to be solidly filled up with rubble, gravel, and lime, which is to be well mixed up and racked into the spaces between the sills. The whole surface is then to be covered with a flooring of 4-inch fir or beech plank, which is to be closely jointed; and well spiked down to the sills by 8-inch spikes: upon this foundation the inverts and walls are to be built. A stone apron invert and pointing sill is to be formed, the arch joints radiating to the different centres. The apron is to be 1 foot 8 inches, and the pointing sill and inverts 2 feet 6 inches deep; each course is not to be less than 12 inches thick, and to bond over each other at least 15 inches. The whole of the inverts to be truly worked and set, to be fair dressed in the beds and joints the whole depth, and solidly laid in Aberthaw lime mortar. The side walls are to be built of ashler, with at least 12 inches of good joint, and not less than 12 inches thick, having headers at every five feet; the headers not to be less than 18 inches broad on the face, and 4 feet deep on the bed; the stretchers not to be larger than 5 feet, nor less on the bed than 2 feet. The whole to be smoothly dressed on the face and joints. The back of the ashler and counterforts is to be built of stone, of the same thickness as the front, fairly dressed on their beds and joints. The hollow quoins are to be made of large stones bonding into the wall alternately, 3 feet 6 inches to 4 feet, to be neatly worked and truly set to receive the heel post of the gates. To build up a foundation of the same description of masonry as the counterforts for the chain holes at the back of the walls, 6 feet wide; the holes to be 2 feet 6 inches square, and faced with ashler; coursed masonry in regular courses from 9 to 15 inches thick. A stop-gate groove, 13 inches wide, is to be made at each side of the gates. The wing walls on the sea side of the docks to each pier, from the invert of the entrance to the jetty banks, are to have a row of sheeting piles, shod with shoes weighing 12 lb. each, and to be driven from 12 to 15 feet into the solid ground, under the toe of the wall; and their heads are to be secured by walings 12 inches wide and 6 inches thick, fixed on each side, and well bolted thereto by 1¼ inch bolts placed about 2 feet 6 inches apart. These piles are to be driven at right angles to the radiation of the wall. The inside wall of the pier is to have a similar row of sheeting piles. When the whole of these piles have been driven, the wing walls are to be commenced: they are to be 6 feet 6 inches wide at the bottom, diminishing to 5 feet wide at the top, and to consist of a footing course of stone of 15 inches thick in alternate header and stretcher courses. The headers to be 2 feet 6 inches wide, and 4 feet 6 inches deep on the bed; and the stretchers to be 4 feet long, and 2 feet 6 inches deep on the bed; and two thorough bonding courses, 15 inches thick, are to be built in the middle of the wall. The space between the bonding courses is to be faced with coursed ashler about 12 inches thick, having good bonders at every five feet. The whole to be well squared on the bed and joints. The stone facings are not to average a less depth on the bed than 18 inches. Counterforts are to be built 17 feet from centre to centre, and 4 feet square, having the bonding courses running through to tie them to the wall. The whole of the entrance and wing walls on each side are to be coped with stones 4 feet wide and 15 inches thick, and not less than 3 feet long, neatly worked, rounded, and well joggled together by stone joggles 3½ inches square. The back walls and counterforts are to be built of solid stone well worked on the beds, and of the same thickness as the front of the wall.

A retaining quay wall is to be built from the wing walls to the

head of the dock. This wall is to be built 4 feet above high-water mark, and to be founded 2 feet below the bottom of the dock, making it 26 feet high from the toe to the coping: it is to be founded upon a row of 6-inch sheeting piles, driven from 8 to 10 feet into the ground, having walings 12 by 6 fixed on each side of their heads, and well secured to the piles by wrought-iron bolts 1¼ inches square, placed about 3 feet apart. A course of stone 15 inches thick is to be laid in the clay, as before described, for the wings, and two bonding courses and coping with an ashler facing, and backing the same as the wing walls; at all parts where the foundation does not appear sufficient to support the superstructure, the same is to be strengthened by bearing piles driven to the solid ground, and covered with sills and planking.

The quay or retaining wall is to be made in a curvilineal form in the vertical section, struck from a radius of 72 feet, the centre of which is to be level with the top of the wall. The bonding and ashler courses are to be worked on the beds to radiate 100 feet, and the beds of the counterforts are to be kept to the level bed, care being taken that the bonding course is properly worked, so as to bond the wall and counterforts well together.

The heel post of the gates to be of oak 14½ by 14, and the mitre is to be 13½ by 13½ the middle bars are to be 11 and 10½ by 12½. The whole of the gates are to be well framed and properly secured by wrought-iron T irons 3½ inch wide, and ⅜ of an inch thick; they are to be let flush into the wood-work on one side of the gates, and well secured thereto with ¾ of an inch wrought iron screw-bolts and rivets. The top and bottom bars are to be well set up to the mitre and heel post with folding wedges. The framing is then to be covered with the best Memel or red pine plank, 3 inches thick, sawed free from sap; to be closely jointed and properly prepared, and well spiked to the framing.

The whole of the wood-work is to be covered with two coats of mineral tar, and the gates are to be made perfectly impervious to water. To fix a brow or gangway 3 feet wide upon each gate, to be made of 2½ plank fixed upon cast-iron carriages, having posts and rails on one side. To provide and fix one pair of anchor plates 1¾ inch thick, and let them into the masonry; to let in five wrought iron holding-down bolts to each plate, and run the whole in with lead. To provide and fix wrought iron hoops, straps, and keys to the top of the gates, and provide and fix brass caps and iron gudgeons for the bottom of the heel posts, which are to be well secured to the gates and masonry.

To provide and fix two sluices in each gate, each 2 ft. 6 in. wide, with frames and paddles, to be made of cast iron and brass facings 2½ wide by ¼ thick, well fitted and rivetted to the frames and paddles, having a wrought-iron rod to each paddle, and to be worked by sufficient sized screws. To provide and fix cast-iron rollers 10 inches diameter, with carriage boxes in each chain hole to divert the chains at the different angles, and to provide and fix four mechanical purchases, one to be fixed at each chain hole, to open and shut the gates. A cast-iron sector plate, 3½ inches thick and 4 inches wide, is to be fixed under each gate, and to be well secured to the stone apron. A roller 16 inches diameter and 3½ inches wide is to be fixed near each mitre post, to be well secured, and regulated by a screw and rod.

Three cast-iron sluice pipes 3ft. 6in. diameter are to be fixed in the head wall of the dock, having cast-iron paddles, worked by a rack and pinion or a screw, for scouring out alluvial deposit.

The whole of the mortar is to be composed of one part of well-burnt Aberthaw lime and three parts of clean sharp river sand; the lime and sand are to be mixed up together during the operation of slacking; to be well mixed and thoroughly incorporated together in a mortar mill, and mixed with as little water as possible. The stone used for the facing is to be of the best quality found in the neighbourhood, and such that has been tried in water works.

The whole of the works above described, both as respects the quality of the materials and mode of execution, is to be performed in the most complete and workmanlike manner, and to the entire satisfaction of the engineer appointed by the directors of the Llangennech Coal Company for the special purpose of directing the work according to such plans and directions as may be given from time to time by the said engineer, who shall have full power and be at liberty to make such alterations, additions, and deductions in the same as he may think proper, or as the nature of the foundations and other circumstances may require (allowance being made to the contractor where additions are made, and deductions where diminished, according to the rate at which the work is undertaken); and should the contractor refuse to comply with any order or orders that may be given by the said engineer, or not proceed with due expedition in the execution of the work, the said directors, upon the representation of the said engineer, shall have full power to dissolve the contract, and take the work out of his hands. The value of the work which shall have been performed shall be paid to him according to the rates and prices mentioned in his tender, and the value of such tools and materials as shall have been provided expressly for the occasion shall be settled by the principal engineer.

The contractor is to find all his own tools, implements, materials, and labour, of every description that may be necessary to carry on and complete the work. The contractor is also to make and maintain all coffer-dams and stanks, and to find all pumps—to keep the work clear of water—to take upon himself the risk of all accidents and damages that may arise during the progress of the work, and to make the same good at his own cost and expense; and if after the work shall have been performed, any imperfection or insufficient workmanship, or any leakage shall appear, the contractor is to make the same good at his own expense, so that the whole of the works shall be delivered completely finished and perfected in all their parts to the Llangennech Coal Company; and if any dispute or difference of opinion, or question, shall arise respecting the nature and terms of the specification, or respecting the mode of admeasurement of any of the works above described, the same shall be determined by the engineer appointed by the said company for that purpose, whose decision shall be final and binding on all parties.

The contractor will be required to give in a tender for the whole of the works above described at a gross sum. He will also be required, at the same time, to give in a detailed list of prices for executing the different kinds of work, as above specified.

GEORGE RENNIE.

INSTITUTION OF CIVIL ENGINEERS.

Description of the Tunnels situated between Bristol and Bath, on the Great Western Railway, with the Methods adopted for executing the Works. *By* Charles Nixon, *Assoc. Inst. C. E.*

THE works described in this paper comprised a large quantity of heavy earth-work in tunnels, &c.; they were commenced in the spring of the year 1836, and terminated in the year 1840. The whole of the tunnels are 30 feet in height from the line of rails, and 30 feet in width; they are

curved to a radius of about 120 chains; the gradient of that part of the line is 4 feet per mile. The strata through which they were driven consisted generally of hard gray sandstone and shale, with the gray and dun shiver, &c.; in a few places only, the new red sandstone and red marl were traversed. Every precaution was taken for securing the roofs, by lining them with masonry where the nature of the strata demanded it, and in some places invert arches were turned beneath.

Driftways were driven before the tunnels were commenced, and shafts were sunk to enable the work to proceed at several points simultaneously. The modes of conducting the works by these means are fully described, with all the difficulties that were encountered. The construction of the centres is given, with the manner of lining the arches with masonry, which is stated to be what was termed "coursed rubble;" but was of a very superior description, and in every respect similar to ashlar work.

The author offers some remarks with regard to the expense of working tunnels by means of centre driftways. He states this plan to be costly, and in many instances without corresponding advantages, on account of the difficulty of keeping the road clear for the waggons. He recommends that when driftways are used, they should be on the lower side of the dip of the strata, as the excavation would be facilitated, and the road would be kept clearer. In long tunnels he has found the cheapest and most expeditious mode of working to be by excavating the centre part from shafts, and both the ends (together if possible) from the extremities, after the open cuttings are made.

In answer to questions from Mr. Vignoles and other members, Mr. Nixon explained that the extra number of shafts had been required in order to enable the works to be completed within a given time: there had not been any accidents during his superintendence, but subsequently one of the shafts had collapsed. The cost of driving the driftways, the dimensions of which were 7 feet wide by 8 feet high, was ten guineas per yard lineal. He then described more fully his proposed plan of cutting the driftways on the lower side, instead of the centre of the tunnel, and stated the advantages chiefly to consist of a saving in labour and gunpowder, as a small charge sufficed to lift a considerable mass of rock when acting from the dip: the road was also less liable to be closed by the materials falling into it when the enlarged excavation proceeded from one side instead of upon both sides.

Dr. Buckland, after returning thanks for his election as an honorary member of the Institution, expressed his gratification at the prospect of a more intimate union between engineering and geology, which could not fail to be mutually beneficial, and cited examples of this useful co-operation in the cases of railway sections and models that had recently been furnished by engineers to the Museum of Economic Geology.

He then proceeded to remark upon the geological features of the South-western coal-field near Bristol and Bath, which had been described by Mr. Conybeare and himself, in the Transactions of the Geological Society of London (1824).

Some of the tunnels near Bristol are driven in the Pennant grit of the coal formation, where it is thrown up at a considerable angle, and composed of strata yielding slabs and blocks of hard sandstone, used extensively for pavement.

In traversing such inclined and dislocated strata, the engineer's attention should, he conceived, be especially directed to the original joints that intersect the beds nearly at right angles to their planes of stratification, and also to the fractures produced during the movements they have undergone. These natural divisions and partings render such inclined stratified rocks unworthy of confidence in the roof of any large tunnel, and liable to have masses suddenly detached.

Inclined strata of a similar sandstone are perforated by many tunnels on the railway near Liège, in nearly all of which the roofs are supported by brick arches.

It has been found impossible to make the tunnels through lias and red marl without continuous arches of masonry.

In any of the tunnels which have been carried through strata of the great oolite, the parts left unsupported by masonry would, in his opinion, be peculiarly liable to danger, because even the most compact beds of oolite are intersected at irregular intervals by loose joints at right angles to the planes of the strata, and occasionally by open cracks; and it is to be feared that the vibration caused by the railway carriages would tend eventually to loosen and detach these masses of stone.

He apprehended still greater danger would exist in tunnels cut through the loosely jointed strata of chalk, unless they are lined throughout with strong masonry; and even that, in a recent case, had been burst through by the weight of the incumbent loose chalk coming suddenly upon the arch.

In open cuttings through chalk, where the numerous interstices and the absence of alternating clay-beds prevent any accumulation of water, there is little chance of such frequent landslips as occur where beds of stone, gravel, or sand, rest on beds of clay; but until the side walks of chalk are reduced to a slope at which grass will grow, they will be subject to continual crumblings and the falling down of small fragments, severed by the continual expansion and contraction of the chalk, under the destructive force of atmospheric agents, and chiefly of frost.

In open cuttings, where the inclination of the strata is towards the line of rails, the slope should be made at a greater angle than if the strata inclined from the rails; if this be done, fewer landslips will occur from accumulations of water between the strata thus inclined towards the rails; and such slips may be further guarded against by minute and careful observation of the nature of the individual strata, and a scientific application of subterranean drains at the contact of each permeable stratum with a subjacent bed of clay.

Tunnels can be safely formed without masonry in unstratified rocks of hard granite, porphyry, trap, &c., and in compact slate rocks; also in masses of tufa, such as cover Herculaneum, and are pierced by the grotto of Pausilippo near Naples: but, in his opinion, wide tunnels driven in stratified rock could not be considered secure unless they were supported by arches.

Mr. Sopwith confirmed the remarks on the importance to the Civil Engineer of a knowledge of the geological character of the strata through which tunnels or open cuttings were to be made: the cost was materially affected, as well as the stability of the works. The angle of inclination and the lines of cleavage should be carefully studied: on one side of a cutting the slope might be left steep, and all would be firm and dry; whilst on the other, if the same slope was adopted, all would appear disintegrated and wet, and a series of accidents would be the necessary consequence. He could not sufficiently urge the importance of a more intimate connexion between the Geologist and the Engineer.

In answer to a remark by Mr. Farey on the apparent advantages of Frazer's Centres for Tunnelling, Mr. Bull promised to procure for the Institution an account of the execution of some work with them.

Description of a Flax Mill recently erected by Messrs. Marshall and Co., at Leeds. By James Combe, *Assoc. Inst. C. E.*

The mill described in this communication consists of one room, 396 feet long by 216 feet wide, covering nearly two acres of ground. The roof is formed of brick groined arches 21 feet high by 36 feet span, upon cast-iron pillars: an impermeable covering of coal-tar and lime is laid on a coating of rough plaster over the arches, and upon that is a layer of earth 8 inches thick, sown with grass. This immense room is lighted and ventilated by a series of skylights 13 feet 6 inches diameter; one at the centre of each arch. A vaulted cellar with brick pillars extends under the whole of the building, and contains the shafts for communicating the motion from a pair of engines of 100 horses' power, to the machinery in the mill; the flues and steam cases for warming and ventilating; the revolving fan for urging the air into the room, with the gas and water pipes; and the remainder of the space is appropriated for warehouses.

The heating and ventilating are effected by a large fan, which forces the air through the pipes of two steam chests, each 10 feet long, and containing together 364 pipes of 3¼ inches bore: the temperature can be regulated by the quantity of steam which is admitted into the chests, or by allowing a portion of cold air to pass by without traversing the pipes; valves and doors in the flues permit any temperature which is desired to be obtained, or that degree of moisture which is essential for some part of the process of working flax.

The general details of the construction of the building are given, with the dimensions of the brick and stone work; the cast-iron pillars and caps, the wrought-iron tie-bars, with the reasons for adding a second set after the accident occurred to the first set; the mode of drainage from the roof; and the striking the centres of the arches, &c.

The total cost of the mill, including the ornamental stone front, was £27,443, which is stated to be about the same cost as that of a good fire-proof mill on the common plan; but as this mode of construction was novel to the workmen, it is probable that a second building of the kind would be less expensive.

The advantages resulting from the plan are, convenience of supervision, facility of access to the machines, the power of sustaining uniformity of temperature and moisture, the absence of currents of air which are so objectionable in other mills, the simplicity of the driving gear, and the excellent ventilation, which is so desirable for the health of the work-people.

The paper was illustrated by two drawings, with a sheet of reference, and an appendix contained the result of some experiments on the strain on the tie-bolts, the pressure on the arches, and the deflection of the bolts, &c.

Mr. Smith was much pleased to find this description of building brought before the Institution, as he had been the first to adopt it for a weaving shed of the extent of half an acre; the columns for carrying the arches were 30 feet 6 inches apart, and the skylights were 8 feet in diameter; some of the arches were of brick, with stone springers; others were entirely built with rubble stone well grouted, which latter mode of construction he found succeeded quite as well as brick; the settlement of the arches on striking the centres after standing four days was only ⅛ths of an inch. The arches were thickly plastered with common mortar, and at first were only covered with a coating of boiled coal-tar pitch and lime ⅛ths of an inch thick, but, as the wet penetrated, the thickness of coal-tar pitch was increased to ¼ths of an inch, with a mixture of sharp sand, which had proved perfectly water-tight: for some months there was an appearance of moisture, which proceeded from the interior of the brickwork, as it could not escape outwards on account of the impermeable covering; after some time the copious ventilation carried off this moisture, and the building became perfectly dry. Over the coal-tar a thickness of earth is laid, which is cultivated, and has proved a prolific garden. In severe weather the frost has not reached above 1½ inch deep in the soil, while it has penetrated to the extent of 12 inches in other situations.

The construction of the floor is peculiar. It is desirable in such weaving sheds to have a boarded floor, to prevent the small parts of the machinery from being broken by falls, and also on account of the health of the persons employed; but the vibration of an ordinary wood floor is objectionable. In order to meet these views, a bed of concrete was laid throughout the building, a series of small deal spars 1½ inch deep by 1 inch wide were set flush into the concrete whilst it was wet, and the whole surface was smooth plastered: upon this bed, when it was perfectly dry, a floor of boards 1½ inch thick] was nailed to the spars; it was found to combine the solidity of pavement with all the advantages of a wood floor, and there had not been any symptoms of dry rot; which might be attributed to there being no cavities left beneath the boards, the whole being firmly bedded down.

The ventilation was effected by tunnels beneath the floor, the covers of which were pierced with a number of small holes to spread the air. The warming was accomplished by means of hot water circulating under the pressure of the atmosphere only, in "tubes of tin plate" 4 inches in diameter: the temperature was very regular, and perfectly under control. With one ton of coal per week the shed could be kept up to 70° during the winter.

The cost of this building was 30 shillings per square yard of area covered, which was less than the cost of Messrs. Marshall's mill, but building materials were much cheaper at Deanston than at Leeds. He expected that this mode of building would become more general, as it combined many advantages, and whatever might be the first outlay in purchasing ground, the cost of which was the only inducement for constructing buildings of several stories in height, it would be fully compensated by the facility of superintendence alone, as in manufactories this was of the utmost importance.

LONDON ELECTRICAL SOCIETY.

Tuesday, Oct. 18.—A notice was entered on the minutes that Walter Hawkins, Esq., M.E.S., F.L.S., &c., had presented the society with a third specimen of the *Gymnotus electricus*; it has unfortunately met with the fate of those which preceded it, namely, not to survive the voyage: it is at present in the hands of Mr. Latheby, who dissected the last specimen, from whom the Society will receive the results of further dissection. Mr. Hawkins expresses the intention of persevering until he secures for the Society a living specimen.—The first paper read was a report of a fatal accident by lightning, at South Blaney, Cornwall, from Mr. Phillips, M.E.S. Several children had taken refuge in a low hut, appropriated as a toll-house. Within not many yards was a very high house, and also (on the other side) a crane, with its metal appurtenances. The flash rejected these, and struck the cottage: it appears to have divided itself among the indifferent conductors. Two of the children were killed, and the others more or less hurt. The notice was accompanied by a sketch of the hut and adjacent buildings.—A translation, by Mr. Walker, of the commencement of M. Becquerel's researches on the electro-chemical properties of simple bodies, was read. The series, of which this is the first, are truly practical papers, the object of the writer being to furnish practical information relative to the employment of the principles of electro-chemistry in the several operations on metals, from the mine to the fabricated work of art. He commences, after a forcible introduction, with gold; and, in the translated portion then read, alludes to the present mode of extracting the precious metal from the ore. The result of experiments on the waste thus incurred are then detailed, and directions are given as to the better methods of operating. The subject will be resumed at a future meeting.—Some theoretical opinions relative to the non-identity of chemical and electrical affinities, by Mr. Prater, M.E.S., were then read.—Mr. Weekes's Electro-Meteorological Register was then laid before the Society.

PROPOSED PLYMOUTH AND EXETER RAILWAY.

ABSTRACT OF MR. MACNEIL'S REPORT ON THE SEVERAL PROPOSED LINES.

(*Continued from page* 286.)

From this statement it will be perceived that Mr. Rendel's South line will return the greatest rate of interest, and that the capital required for its construction is less than will be required for either Mr. Brunel's line, or the line composed partly of his and partly of Mr. Rendel's, the difference being nearly £400,000 in the former case, and £200,000 in the latter.

The annual expense, however, of working his line exceeds that of working Mr. Brunel's line by locomotive and stationary power nearly £20,000 a year, and the combined line £8,000; but this difference in a great measure arises from passing the Perridge summit at so high a level, in order to obtain a short tunnel. By making that tunnel a mile long instead of 950 yards as at present, at least 100 feet of elevation would be saved, and the gradients leading to and from it would be so far reduced as to diminish the cost of working very materially. In laying out the line for final execution, many improvements and modifications would undoubtedly be made, so as to improve the curves, lessen the expense of construction, and do away with any objections that may be made by landed proprietors.

Though the Dartmoor line has much to recommend it, and would give railway accommodation to Tavistock by means of a short branch, 4¾ miles, as shown in the plan which accompanies this Report, yet Mr. Macneil without hesitation gives it as his opinion, that the line of railway already pointed out through the South Hams would be more generally useful, and more profitable to the shareholders.

With respect to Captain Moorsom's line, it is evident from the preceding tables of calculations that it cannot compete with the other lines from Exeter to Plymouth, considered merely as a line to connect those towns, without reference to an ulterior object of forming a communication between Exeter and Falmouth, the consideration of which was not embraced in the instructions received from the Provisional Committee. It should therefore be considered as a railway to Falmouth, forming a communication with Plymouth, by a branch from Lidford, and as such must be compared with the route through Plymouth by the Dartmoor or Southern lines already described, in conjunction with their extension from Plymouth to Falmouth, as surveyed by Mr. Rendel. The line of Captain Moorsom, which is described in the plan and sections accompanying Mr. Macneil's Report, follows the valley of Lyd river, crossing the Tamar to Launceston (population 4586), whence across the moors near the Brown Willey, and by the Helland river to Bodmin (population 4,643), whence following the general line of the new turnpike road to St. Austell (population 10,320), it passes towards St. Stephens by Tregellon summit, where it passes close to the proposed extension of the Exeter and Plymouth railway, *via* Torpoint. Captain M.'s line passes near Landock, Tresilian bridge, to near Truro (population 15,000), whence it passes near Penryn (population 3,337) to Falmouth. Mr. Rendel's has been before described, and is shown more particularly by the plan and sections. By this it appears that the direct line surveyed by Captain Moorsom, from Exeter to Falmouth, is 108 miles, with a branch to Plymouth of about 21 miles, which would together involve the formation of about 129 miles of railway, and make the distance from Exeter to Plymouth 54¼ miles, and from Plymouth to Falmouth 95½ miles; whereas by the line through the South Hams, the distance from Exeter to Plymouth would be only 49¼ miles, and from Plymouth to Falmouth, or rather to the pool of St. Just, 56¼ miles—making the total distance about 105 miles; by this route, therefore, there would be a saving in distance between Exeter and Plymouth of about 5 miles, between Plymouth and Falmouth of 39 miles, and on the whole distance between Exeter and Falmouth a saving of 3 miles, whilst the saving in railway construction, as compared with the line by Lidford, would be about 26 miles.

THE TEMPLE CHURCH.

The restoration and repair of the Temple church, at once the most beautiful and perfect memorial of the Order of Knights Templars now in existence, cannot fail to be a subject of congratulation to the country at

large. It is pleasant to reflect, that beneath the surface of this bustling and money-loving world there is a strong undercurrent of enlightened feeling respecting the care of our national edifices. The ancient abbey of St. Alban's, Crosby Palace, and Our Ladye's Chapel, Southwark, are among the more recent structures preserved from decay by the honourable and ready contributions of subscribers from all ranks of society. The expense and magnificence of the repairs in the Temple church promise to surpass any similar attempt in this country, the whole of the enormous outlay required being jointly borne by the two societies of the Inner and Middle Temple.

Those persons to whom the Temple church was familiar in its late dress of plaster and whitewash will scarcely recognize the ancient structure in the gorgeously decorated appearance it now presents. The repairs were commenced in 1840. The dilapidated state of the building, in great measure owing to the reckless manner in which the walls and pillars had been overlaid with heavy monuments, rendered these works necessary, and, in accordance with the improved taste now prevalent in the public mind, the benchers were led to extend the mere repair into a restoration of the building as nearly as possible to its original state. The architect who commenced these works was Mr. Savage, but owing to some differences between that gentleman and the building committee of benchers, the charge was transferred to Mr. S. Smirke on the part of the Inner Temple, and Mr. S. Burton on that of the Middle Temple. It is, however, due to Mr. Savage to state, that the plans prepared by himself have been in a great measure carried out by his successors.

The Entrance Porch is for the most part new, the excessively ornamented old doorway having been partly renewed, and the remainder reworked and restored.

The Circular Nave.—The six clusters of old Purbeck marble columns, which formerly supported the whole superstructure, have been removed, and new columns of the same material substituted. The ceiling of the centre part (a truncated dome of comparatively modern erection) has been taken down, and a new oak vaulted and grained ceiling substituted, painted by Mr. Willement, strictly in accordance with the style of the period. The whole of the walls, arches, and aisle vaults have been reworked, and new polished marble shafts substituted for the old columns. The sculptural figures of the Knights Templars have been restored in the most perfect manner, and will again occupy their former positions.

The Triforium of the Nave has been converted into a depository for nearly all the monuments which formerly disfigured the walls of the church. This gallery, common in all cathedral edifices, now forms a handsome promenade of 12 feet wide and 15 high round the circle, the mural tablets of most of the eminent lawyers of the last two centuries being carefully arranged on either side. They are much better seen than formerly, and form an interesting collection of monumental sculpture.

The Square Chancel.—This part of the church, hitherto filled with pews, which concealed the bases of the marble columns (themselves hidden by a thick coating of plaster and paint, through the over-anxious desire to efface all emblems of the Popish faith on the part of the Protestant lawyers shortly after the Reformation, and encumbered to a height of eight feet from the ground with oak wainscoating, shutting out the view of the elegant marble piscina on the south side of the building, has been entirely cleared of these unsightly additions. The huge pulpit and organ-screen are also removed, and a new and elegant gallery for the reception of that instrument has been erected on the north side, occupying one bay, with a vestry beneath. The walls of the latter small apartment are studded with monuments, among which the most conspicuous are those of Lord Eldon, Lord Stowell, and Oliver Goldsmith. The north and south aisles are each divided into five compartments; the eastern division will be occupied by the benchers' ladies, and that adjoining by the benchers themselves, every seat having distinct and elaborately carved elbows. The two next are occupied by the barristers, and the remaining division by the barristers' ladies. The members of the Inner Temple will occupy the south, and those of the Middle Temple the northern side of the church. The whole of the centre is fitted up with sittings for the students, in the cathedral style of arrangement. The most prominent object on entering the chancel from the western porch is the triple-lancet window over the altar. This beautiful specimen of stained glass, executed by Mr. Willement, F.S.A., is intended to represent the principal events in the life of our Saviour. In the first division are the annunciation, the nativity, the angels appearing to the shepherds, the wise men before Herod, their progress towards Bethlehem, and their adoration of the infant Jesus. The centre division contains the flight into Egypt, the presentation in the temple, Christ before the doctors, the baptism, the marriage at Cana, the calling of St. Peter, the transfiguration, the entry into Jerusalem, the last supper, Christ before Pilate, bearing the cross, the crucifixion, Joseph begging the body of Jesus, the soldiers guarding the sepulchre, and, in the extreme upper point, the resurrection. The third division contains representations of those events which took place after the crucifixion. The interstices of each of the divisions are filled up a mosaic of the richest coloured glass, and enclosed within broad and elaborately ornamented borders. On each side of this window are three other openings, containing subjects in stained glass illustrative of the history of the Knights Templars,—viz., the Temple at Jerusalem, and the city of Bethlehem, the armorial bearings of the founders and benefactors of the order, and equestrian figures of those masters who commanded in England during the erection of this edifice. The style, details, and costume of every part evidence the most careful antiquarian study, and the arrangement of the various tints presents the most perfect harmony. On the south side of the church, facing the organ, is another painted window, totally different in character. In this the principal ornaments are five whole-length figures of angels, playing on various musical instruments. The remainder of the window is filled by delicately-drawn ornaments on a reticulated ground, relieved by rosettes and bands of coloured glass. In the clerestory of the round church there is at present only one window of stained glass, representing our Saviour enthroned between the evangelists. The prevailing colours used for the decoration of the walls and roof of the chancel are blue and red. The ceiling is divided into compartments, alternately ornamented with the armorial bearings of the two inns; the lamb and staff for the Middle Temple, and the flying horse for the Inner Temple. Figures of several of the early kings of England are emblazoned on the western wall, and the shield of the holy cross worn by the Knights Templars is frequently introduced. The altar is entirely new, from the design of Mr. Smirke. The creed and commandments are painted black, on a gold ground, with illuminated initials, producing a remarkable richness of effect. The whole of the designs for the stall-ends and elbows, consisting of grotesque heads and foliage of the most elaborate description, have been furnished by Mr. Cottingham, of the Waterloo-road.

The desk now erected is merely temporary, it being considered prudent to ascertain the most eligible position by actual experiment, previously to the definite adoption of a site for the handsome carved oak pulpit which is in preparation. It is not intended to erect a reading-desk—the creed and lessons will be read as in collegiate establishments. The organ, one of the few superb instruments built by Schmidt, more than a century since, has been entirely reconstructed by Bishop, who has greatly extended its power by the addition of 15 large pedal pipes, and corrected a few defects in the original. The floor is paved with glazed encaustic tiles, copied exactly from ancient examples. This is not expected to be completed by the day appointed for the reopening of the church for public service, owing to the entire stoppage of the works at the Potteries, in Staffordshire, during the late disturbances.

The bell, which was formerly in the roof of the circular nave (although that was not its original place), has been removed, and hung in a new stone belfry turret erected over the Newell staircase on the north side.

The churchyard is being paved and otherwise improved, and it has been determined by the benchers to allow no more interments therein. It will be recollected that the musical service of the Temple church was formerly a great attraction. The benchers have now decided on introducing a choir, and the service will be performed in the cathedral style. The interest excited by the opening announced for Sunday, the 6th of November, is very great, and, notwithstanding much remains to be done, it is confidently expected that service will be performed on that day. The church is daily visited by a number of the nobility and gentry. The Bishop of London went over it on Thursday the 20th, and expressed his unqualified admiration and approval of the effect produced by the style of decoration adopted. On Saturday the Rev. Lord Augustus Fitzclarence spent several hours, accompanied by Mr. Burge, Queen's Counsel (one of the most active members of the building committee), in scanning its details, with all of which the noble lord expressed himself much gratified.

The Rev. Mr. Benson (the present Master of the Temple, arrived from Italy) a few days since, for the express purpose of taking part in the opening service.

STATUARY—HOW FAR IRON IS A SUITABLE MATERIAL.

IN A LETTER FROM B. CHEVERTON, ESQ., TO THE EDITOR OF THE MECHANICS' MAGAZINE.

Sir,—The proposal to cast statues in iron, attributed to me by your correspondent, Mr. Partridge, was, I believe, suggested or advocated rather by Sir John Robison, and is one which I should hesitate to recommend. I speak generally, for there is one case to which I shall presently advert, in which undoubtedly iron would be the best material.

In matters relating to art and taste, circumstances will ever predominate over principles in guiding the judgment to a correct conclusion. Every case will have its own adjuncts and conditions, and to a fine natural or skilled perception of the fitness and propriety of things, must be left the task of adjusting, proportioning, and harmonizing them with artistic effect. No one material is best or good for the purposes of statuary under all circumstances, be it ivory, marble, alabaster, bronze, or iron; and this proposition is true if taken in reference merely to art, and independent of durability, or of economical considerations. The nature of the material in regard to its opacity, or its degree of transparency; the character of its reflected and its transmitted light; the depth and quality of the shadow that it casts; the nature of the material in regard to its surface, its power of scattering and of absorbing light, its mechanical texture and its colour, both in themselves and as bearing on the above several points; are all circumstances of suitability which must be consulted in connexion with other circumstances of light, size, and locality, before any opinion can be safely advanced as to the preference of one material to another in any given case. I believe I state the opinion of artists in general, that of all the materials I have mentioned (except, perhaps, alabaster in quite the opposite direction) iron is in point of taste the most unfit for statuary works of art.

Economy, it is true, is a powerful consideration, and is too apt in the present day, even in departments of art, to overrule all other considerations, but it is not so much in favour of iron for statues as may be imagined. The cost of these expensive productions of art lies not in the material so far as bronze is concerned, which amounts not to more than from the fifteenth to the twentieth part, but in the reward which genius of the highest order, or at least of the first existing rank, will always command,—in the *artistic* talent required in aid of the subordinate modelling,—and in the great quantity of *skilled* labour employed in the manipulation of every part of the work. In the last particular, the use of iron would entail great additional expense, from the difficulty of bringing the castings to anything like a tolerable surface, and from the greater magnitude of the operations—it being impracticable *to burn*, that is, to fuse the castings of the several parts to each other, as is done in bronze.

If it be proposed to coat the iron with copper by the electro-metallurgic process, I am quite confident, from the considerations just named, and from the additional manipulations required, that the expense would be greater than by the present mode of casting in bronze. The statue also would require to be large, and the coating thin, in order to avoid perceptible distortion. The better way in every respect would be to employ electro-metallurgy in the entire formation of the statue, first depositing in the interior of a mould a sufficient thickness of copper, and then strengthening it by a deposit of a cheaper metal, as zinc. Or, an alloy may in the first instance be deposited of copper and zinc, in accordance with Barret's patent process, reducing the proportions rapidly, so that zinc may form the great mass of the metal. Even on this plan, I am very doubtful whether the expense would, by any process yet made public, be less in respect to all models of the colossal or the heroic size, requiring but one copy, than that of ordinary casting. Individual and isolated enterprizes in this matter among sculptors would be ruinous failures. The object would only be accomplished with a profit, by an establishment with the *plant* and means devoted to such purposes generally, to whom artists could entrust their models with a certainty of having them back uninjured, and of having also a successful copy. Even such an establishment, and I speak from knowledge, would have to feel their way cautiously, and through gradual operations from the smaller to the larger.

There is a point, I am convinced, though I do not know where it exists, beyond which the electro-metallurgic process would not be advantageous. As we proceed in size, the parts are large in themselves, and are moreover modelled in a massive style, to comport with that size, whereby the roughness of the surface, and the inexactitude of minor details, become matters of so little moment, that the ruder process of casting is amply sufficient. Indeed, the literal transcript of every minutia of the surface which the electrotype gives, is a disadvantage even in the smallest works of art, unless the model be susceptible of, and has received, the highest finish. But in a large statue, the eye, removed to the proper distance, regards only the general form.

I have heard it remarked that the marble statues of Sir Francis Chantrey never produced a finer effect than when seen by twilight in the workshop in a *half-finished* state; that is, just from the hands of the *pointer*. This is a severe but a true test of intrinsic worth, the judgment being unbiassed by meretricious or even adventitious excellence of mere execution, either to enhance the merits of the work, or to extenuate its faults. Now colossal statues are seen, not only in an analogous point of view, but under conditions yet more restrictive and exacting. I allude to those of the first magnitude, and whose situation is of course in the open air; for those of a secondary size, if placed in buildings, and particularly if the material is marble, are not subjected to circumstances so inimical to effect. But the large colossals are placed generally on high—they are seen with advantage only at a distance—and the calculated intention of the style in which they are modelled is, that they should be both seen and appreciated only at a considerable distance. For this purpose, all the parts, and even the features, are massive and few in number. The modelling is in a style of grandeur to correspond with the grandeur of magnitude. The minuter details of likeness are omitted; those that remain are not delineated in literal conformity to the life-size bust of the individual, but are exaggerated to such a degree, that if the artist took the direction of the ludicrous instead of the grand, it would amount to a caricature. So situated, they are exposed to a diffused light unfavourable to shade, and to the discrimination of parts; and this evil is greatly aggravated by the dingy hue which, in our climate at least, they very quickly assume, to the effect of swallowing up shadow in colour. If, in such circumstances, the form, as defined by the general contour, is inelegant or unbalanced, no superficial arrangement or division of parts, however bold in character, will suffice to redeem it; no cutting, however deep, which does not go to the extent of letting the light through, will obviate the bad effect it will have in the distance, although, perhaps, to the beholder, when in the artist's studio, the deep shades thus produced may be thought amply sufficient to afford the relief intended. In these colossals it is the outlines that tell effectively, and also the shadow which projection throws, far more than the shade which incutting affords.*

These observations lead me to the only case in which I can admit that iron would be a proper material for statues; for where artistic skill finds so little room for display—where it is confined to the highest quality of the art, and within limits of such severe simplicity—where the advenient means usually found so effective to portray composition and design, are rendered nugatory by being almost or altogether lost to view, it cannot, in an artistic point of view, be a matter of the slightest importance what the nature of the material is, what the character of its surface, or what indeed its colour, unless the statue can be prevented from becoming black. The microscopic accuracy of delineation afforded by the electrotype process will cease to have any utility long before it arrives at this extreme point, but here it is manifestly useless; even the coarseness of iron castings, the impossibility of fusing them together, the rude and joint-showing method of uniting them by inside flanges, and the inaccuracy of their fittings, are all matters of the utmost insignificance; and therefore iron, as being cheapest and strongest, and the least liable to excite the cupidity, or yield to the fanaticism, of future generations, is undoubtedly in this case the best material that could be employed. Next to this, in the descending order of size, and wholly grounded on considerations of taste, I would rank granite and marble, reserving ivory and bronze for the miniature productions of art; but as our climate is unfavourable to durability in exposed situations, matters of taste must occasionally be overruled by considerations of expediency, and therefore bronze is the best material for statues of a moderate size in the open air. The durability of cast iron is a subject on which I cannot here enter; but if properly protected from special chemical and galvanic influences, in respect both to the constitution of the metal, and to circumstances connected with the construction of a statue, it would surely last long enough to satisfy the most ardent cravings after monumental immortality; as long, at least, as the time when, to use the words of a *prophet*, "a solitary traveller from Australia shall be found sketching the ruins of the last arch of London bridge."

I cannot conclude without adverting with feelings of deep regret to the timidity which is exhibited by patrons of art, and other influential men of taste, in refraining to countenance any monumental design which departs in the least from what precedent has sanctioned, or goes farther, at most, than ringing changes on what it has dictated. Certainly, they are safe within the circle of plain stone columns, and respectable marble, bronze, or stone statues, from any very stinging condemnatory criticism; but if we are always to go on thus, we shall never ourselves be cited as precedents. Let us at least try what we can do in *colossal granite statues*, and having put forth our might to the extent of rivalry, at any rate, with the Egyptian, we may next take courage to go beyond him, and, with that spirit of enterprise and originality which has so honourably marked our onward career in all matters appertaining to public convenience and utility, break away from the leading-strings by which art is trammelled, through a slavish deference to authority. Our Gothic forefathers, self-emancipated from Greek and Roman bondage, created, as well for posterity as for themselves,

* The finest statue in the metropolis for colossal qualities, though hardly itself to be called colossal, is, in my judgment, that of Pitt, by Chantrey, in Hanover-square. Its symmetry and balance, from whatever side, or at whatever distance, it may be viewed, is—if I may be allowed something like an Hibernianism—perfect to a fault. Its outline in any direction is elegant, and pregnant with meaning and indication of what perhaps the spectator is too distant distinctly to perceive through the medium of light and shade. Its style, also, is eminently grand and dignified.

an entire new style in architectural art; and that, too, at a time when scholastic prejudices in favour of the ancients were at the highest. If it be not classic, let it then be British usage, to erect statues in cast iron, but of a size and character so colossal, that, far from militating against the principles of taste, the grandeur of magnitude, and simplicity of design, shall harmonize with the grandeur of strength in the material, and fitly call for the sombre appearance which it presents. What more noble object could have been offered to view in Trafalgar-square—what more characteristic of Britain and the British in a variety of aspects—than a cast iron statue of Nelson, 80 or 100 feet in height? The suitability of the site might indeed, with some reason, have been questioned, inasmuch as the space is too confined to have viewed it properly, and is moreover out of character with that, or anything else that is simply grand. It would have frowned into insignificance the petty prettinesses around. Still, another site more appropriate might have been found, or at least a bronze or a granite statue of some 40 or 50 feet could have been erected, which would have been both a variety in that locality, and a novelty in modern times.*

MISCELLANEOUS.

Supply of Water to the South Side of London.—We are glad to observe that many influential inhabitants and owners of house property, on the south side of the Thames, are again agitating the project of procuring for this part of London a new supply of water, independent of the present companies. It has been shown repeatedly that the idea of procuring this supply from the Wandle is wild and visionary, as the immense interests involved in the mills and other property in that stream will present an opposition too formidable for any new company to contend against. The supply, therefore, must be sought at the sources pointed out by Mr. Gibbs, several years ago, when he deposited with the clerks of the peace a complete set of plans and sections connected with a project for bringing water to London, from the chalk and sands of Merstham. We are not acquainted with the details of this project, but we believe it was intended to convey the water partly in the line of the Brighton and Croydon railways, and to have large reservoirs at Sydenham, Croydon, and several other intermediate places.

Earth Works of the London and Croydon Railway.—We regret to observe that it is in contemplation to flatten the slopes of the great cutting through New Cross Hill, and up to the summit at Forest Hill. It will be remembered that this line has been the scene of several extensive slips, principally (as we contended at the time, and as we still believe) on account of inattention to the drainage of the slopes during the heavy rains of last autumn. We did hope, after all that has been said and written, and, we may add, practically effected in the way of drainage, that a more scientific expedient would have been adopted than that of cutting away more land, and putting the company to the enormous expense of removing more stuff, for the purpose of preventing future slips. We have said, again and again, that these slopes are sufficiently flat, and we now proclaim, that to cut them back at a less angle than that which was originally assigned to them will involve a wicked waste of money and a wanton destruction of good land. The slopes simply require to be drained, and to be weighted at their base with a continuous dwarf abutment of either rubble or dressed masonry, to resist the thrust of the earth above, and oppose its tendency to instability. The force of a slip is never great; it is commonly barely sufficient to overcome the adhesion of the mass which it brings down, and in most cases it would be found, that the slightest assistance given to this adhesion would have had the effect of resisting the tendency to slip, and of preserving the slope in a sound state.

Railway from Newport to Nant-y-Glo.—We are glad to observe that the proprietors of iron works in the Ebbw Vale are at length stirring themselves in this measure. Already have the works of Cyfartha, Dowlais, Pendarron, and many others between Merthyr Tydvil and Cardiff, derived great advantages from the Taff Vale railway; and it is high time that the equally important interests of the Ebbw Vale should, in like manner, be connected with their shipping port, by means of a railway suitable for the passage of locomotive engines.

Map of the London and Brighton Railway, and of the Town of Brighton.—We have before had occasion to speak in highly favourable terms of Mr. Jobbins' plan and section of the South-Eastern (Dover) railway. We may add that the geological map of England, which appears in numbers, and which is reviewed in our columns of this month, is engraved by Mr. Jobbins, from the same reduced copy of the Ordnance survey, on the scale of three miles to one inch. We have also now before us a travelling map of the Brighton railway, compiled from the same authority, mounted, and folding in a neat pocket case, with a map of the town of Brighton. All these maps are decidedly the best of their kind, and the price at which they are sold places them within the reach of every one.

The "Light of all Nations."—The predictions of Mr. Mudie have been remarkably fulfilled in reference to this grand project. After all the overstrained puffing of the *Times*, and most of the other papers, who have followed the example of the leading journal, the "light of all nations" is destined at last to be—not a proud monument of the engineering skill and enterprize of Englishmen—but a miserable failure, and a warning to future visionary projectors, and an enduring proof of the gullibility of honest John Bull. We have heard something of the fame of Mr. Bush, the *distinguished* engineer of this great scheme, descending to posterity, although his immortal light-house has descended to the obscurest recesses of the finny tribes. Be this as it may, we have nothing to say against it. But however great a man Mr. Bush may appear in the eyes of posterity, we heartily trust that the existing generation will listen to no more schemes for sinking iron caissons through the Goodwin Sands. Mr. Bush's reputation with posterity will abstract nothing from the pockets of either the government or of individuals; but we fear that a revival of his mad-brained project would surely swallow up much capital, which might be profitably applied to other purposes; at the same time that it will grossly violate all the common-sense ideas of our countrymen. Whatever becomes of Mr. Bush, therefore, we earnestly pray that an extinguisher may henceforth be put upon his light, and that the attention of government may be turned to some more rational project for effecting the same purpose. The engineering skill of this country is amply competent to devise a sound and feasible design, in lieu of the recent abortive, school-boy undertaking. As we have often heard inquiries as to who and what the Mr. Bush is who has been constructing this glorious "light of all nations," we take the present opportunity of stating that he is not the Mr. Bush who constructed the Llanelly docks and the Taff Vale railway, and who was so generally known and appreciated throughout South Wales. The highly talented and promising engineer of those works has been dead several years, but has often been confounded with his namesake of the Goodwin Sands.

The New Horse Shoe.—In our September Number we gave a detailed account of the proceedings instituted by the Committee of the Practical and Scientific Association for the Improvement of the Streets, to afford to Mr. Rodway an opportunity to illustrate, as far as theory would admit, the presumed advantages of his Patent Concave Shoe, over all other descriptions of horse shoes; and from the exposition then made, we felt ourselves warranted in expressing our entire concurrence in the very favourable opinions given on the occasion; more particularly as supplying the desideratum which had previously existed of a shoe better adapted than the common one for the traffic of horses on wood pavement. It is therefore gratifying to learn that, during the interval of time that has elapsed, the patentee has derived all the benefits of an extensive practical trial of the Concave Shoe, and that the result has realized his highest expectations.

Church of St. Isaac, at St. Petersburgh.—The exterior of this church is nearly completed. The cupola is finished, with the exception of some bronze work which remains to be put up. The scaffolding will shortly be removed, and we shall then be able to judge more perfectly of the architectural effect. The cupola, covered with gilded bronze, has a very rich appearance, and a magnificent panorama presents itself from its summit. The vessels in the Baltic which approach Cronstadt are able to perceive the cupola of the dome glittering in the sun. The rainbow variation of colours during the different times of the day, produces a truly beautiful effect. The emperor has ordered that the three great gates shall be executed in bronze. They will be richly ornamented, and will be upwards of 60 feet in height.—*Revue Générale de l'Architecture.*

Steam Navigation on the Rhine. (From *Le Moniteur*).—In 1816 was started the first steam boat on the Rhine, running between Rotterdam and Cologne. After a lapse of twenty-three years, there were 39 of these conveyances between Basle and the sea, and this number annually increases. The companies rival each other in exertion; but the two Prusso-Rhenish establishments have made the most progress in improvement. The Cologne Company commenced on the 1st May, 1827, with one boat only between Cologne and Mentz; on the 8th June following it had 2, and in 1827 it had 9; viz., 1 of 118 horse power, 1 of 85, 2 of 80, 1 of 75, 3 of 70, and 1 of 50 horse power. In the same year this company had three departures from, and as many arrivals at Cologne, and a regular communication with Strasburgh. In the following year the number of boats was increased to 11; in 1839 to 14; in 1840 to 15; and in 1841 to 20, passing between Cologne and Strasburgh. In 1838

* The largest colossal statue in metal now existing is, I believe, that of Borromeo, on the borders of Lake Maggiore; and, if I recollect aright, it is constructed of copper sheets hammered into form.

the Cologne Company made an association with that running boats between Basle and Strasburgh, which had 2 of 30 horse power each. From this period the passage between Basle and Cologne has been made in 40 hours, 29 of which only are spent on board the boats. Shortly afterwards another company launched 2 boats, which performed the same distance in much less time. The second Prusso-Rhenish Company, which had been formed by capitalists of Mentz and Dusseldorf, commenced running in 1838, with 5 magnificent boats. Once a week one of these boats goes to Rotterdam. In 1838 they conveyed no less than 84,000 passengers, and 60,000 metrical quintals of merchandize; which in 1840 increased to 152,000 passengers and 90,000 quintals of merchandize. This was nothing to what was done by the Cologne Company; for whereas in 1827 its transports amounted to 18,000 passengers and 26,000 quintals of goods, in 1833 it had 100,000 passengers and 106,000 quintals on freight; and in 1840 the number of passengers exceeded 460,000, and the goods on freight 130,000 quintals; and in 1841 these increased to 680,000 passengers and 300,000 quintals. The company which has just been formed at Basle, and which has made a connexion with the Mentz and Dusseldorf Company, will give a fresh impulse to steam navigation on the Upper Rhine. The Netherlands Company (Standelmaatschappy), established at Rotterdam, has traversed between that city and Cologne ever since 1837, with 11 boats, of from 50 to 120 horse power. They run daily, but one boat a week is exclusively employed in conveying merchandize. The navigation of the Rhine is carried on to London by boats from Rotterdam, and they make this passage with such regularity and rapidity, that they insure a great number of passengers and large quantities of merchandize on freight.

LIST OF PATENTS.

(*Continued from page* 288.)

(SIX MONTHS FOR ENROLMENT.)

Edward Bell, of the College of Civil Engineers, Putney, professor of practical mechanics, for "improvements in applying heat in the manufacture of artificial fuel, which improvements are applicable to the preparation of asphalte, and for other purposes."—Sealed September 29.

Samuel Henson, of New City Chambers, Bishopsgate-street, engineer, for "certain improvements in locomotive apparatus, and in machinery for conveying letters, goods, and passengers, from place to place through the air, part of which improvements are applicable to locomotive and other machinery to be used on water or land."—Sealed September 29.

William Smith, of Grosvenor-street, Camberwell, gent., for "improvements in treating certain animal matters, to obtain products applicable to the manufacture of candles, and other purposes."—Sealed September 29.

John Rand, of Howland-street, Fitzroy-square, artist, for "improvements in making and closing metallic collapsable vessels."—Sealed September 29.

James Hyde, of Duckenfield, Cheshire, machine-maker, and John Hyde, of the same place, cotton-spinner and manufacturer, for "a certain improvement or improvements in the machinery used for preparing cotton, wool, silk, flax, and similar fibrous materials for spinning."—Sealed September 29.

John Ridsdale, of Leeds, for "improvements in preparing fibrous materials for weaving, and in sizing warps."—Sealed September 29.

John Fry Wilkey, of Mount Vernon, Exeter, commission agent, for "improvements in carriages."—Sealed September 29.

John George Shipley, of Bruton-street, Berkeley-square, saddler, for "certain improvements in saddles."—Sealed October 6.

John Oliver York, of Upper Coleshill-street, Eaton-square, for "improvements in the manufacture of axles for railway wheels."—Sealed October 8.

Wilton George Turner, of Gateshead, Durham, doctor in philosophy, for "improvements in the manufacture of alum."—Sealed October 8.

Claude Edward Deutsche, of Fricour's Hotel, St. Martin's-lane, gentleman, for "improvements in combining materials to be used for cementing purposes, and for preventing the passage of fluids, and also for forming or constructing articles from such compositions of materials."—Sealed October 8.

Samuel Dotchin, of Myrtle-street, Hoxton, jeweller, for "improvements in paving, or covering, and constructing roads, ways, and other surfaces." (Being a communication from his son lately deceased.)—Sealed October 13.

William Edward Newton, of Chancery-lane, patent agent, for "certain improvements in the manufacture of artificial fuel." (Being a communication.)—Sealed October 13.

Charles Thomas Holcombe, of Valentines, near Ilford, Essex, Esq., for "an improved mode of using certain materials as fuel; also an apparatus or method for collecting the smoke or soot arising from the combustion of such fuel; which apparatus or method is applicable to collecting the smoke or soot arising from the ordinary combustion of fuel, and also the application of the products arising from the combustion of the first-mentioned materials, as a manure, and for other useful purposes."—Sealed October 13.

Robert William Sievier, of Henrietta-street, Cavendish-square, gentleman, for "certain improvements in looms for weaving, and in the mode or method of producing plain or figured goods or fabrics."—Sealed October 13.

Peter Kagenbusch, of Lyth, in the county of York, dyer, for "certain improvements in the treatment of the alum rock, or schist, and in the manufacture and application of the products derived therefrom."—Sealed October 13.

Henry Brown, of Selkirk, manufacturer, and Thomas Walker, of the same place, manufacturer, for "improvements on woollen carding engines."—Sealed October 13.

Thomas Seville, of Royton, Lancaster, cotton spinner, for "certain improvements in machinery used in the preparing and spinning of cotton, flax, and other fibrous substances."—Sealed October 20.

James Palmer Budd, Ystalyfera Iron Works, Swansea, merchant, for "improvements in the manufacture of iron."—Sealed October 20.

William Longmaid, of Plymouth, accountant, for "improvements in treating ores and other minerals, and in obtaining various products therefrom, certain parts of which improvements are applicable to the manufacture of alkali."—Sealed October 20.

James Statham, of West-street, St. Giles's, Venetian lock maker, for "improvements in the construction of locks for Venetian blinds used in carriages."—Sealed October 20.

Gilbert Claude Alzard, of Tichborne-street, gent., for "certain improvements in bread, biscuits, macaroni, vermicelli, and pastry, and the mode of making the same."—Sealed October 20.

George Hazeldine, of Lant-street, Southwark, coach manufacturer, for "certain improvements in omnibuses."—Sealed October 27.

James Gardner, of Banbury, ironmonger, for "improvements in cutting hay, straw and other vegetable matters for the food of animals."—Sealed October 27.

John Mullins, of Battersea, surgeon, for "improvements in making oxides of metals, in separating silver and other metals from their compounds with other metals, and in making white lead, sugar of lead, and other salts of lead, and salts of other metals."—Sealed October 27.

Rowland Williams, of Manchester, fustian shearer, for "certain improvements in machinery or apparatus for raising, shearing, and finishing velvets, or other piled goods, by power."—Sealed October 27.

NOTICE.

A section of the Artesian Well at Paris, and sketches of the boring tools employed in that work, are referred to in the article on Artesian Wells in the present number. We are unavoidably under the necessity of postponing these until next month.

Communications and books for review to be addressed to the Editor, 8, Duke Street, Westminster, on or before the 20th of the month—Advertisements should be sent before the 26th to the Publishers, Messrs. Bell and Wood, 186, Fleet Street, or to the printing office, 90½, Holborn Hill.

To CORRESPONDENTS.—"A Well Wisher and Purchaser of your Journal." His letter is under consideration in the proper quarter. We shall be happy to hear from him again.

BATTERY OF ZINC & COPPER PLATES FOR BLASTING BY CALVANISM.

Fig. 1.

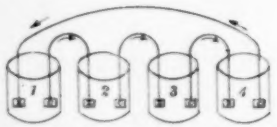


Fig. 2.

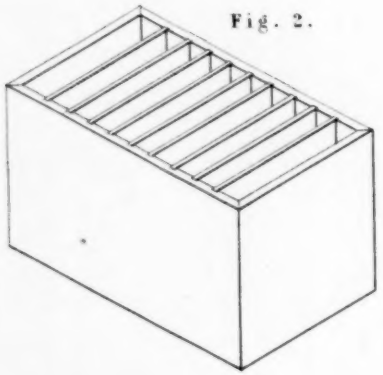


Fig. 3

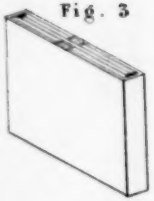


Fig. 4.

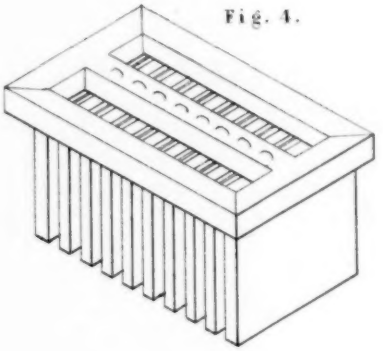


Fig. 5.

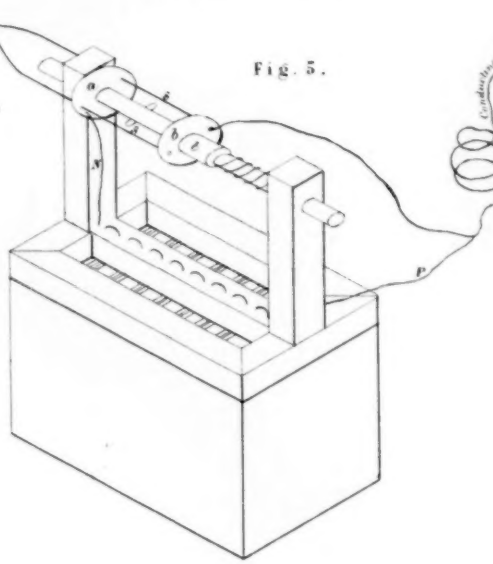
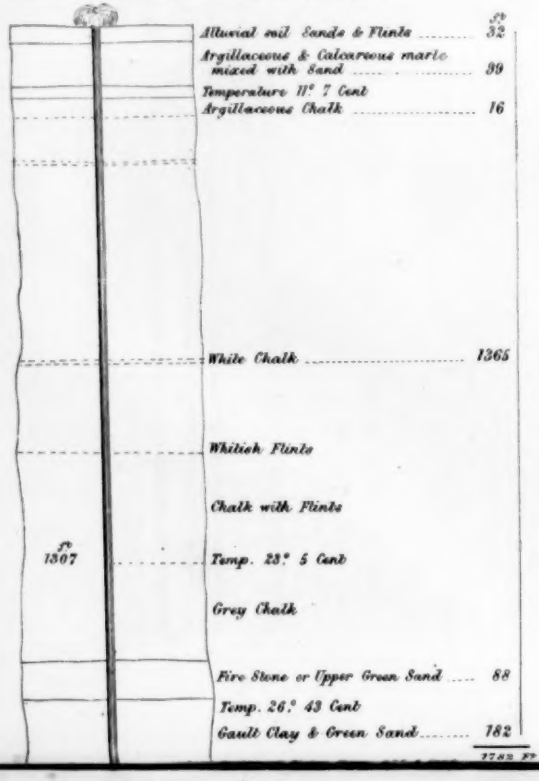


Fig. 6

Section of the Artesian Well at Grenelle.


Alluvial soil Sands & Flints ..... Fr. 32
Argillaceous & Calcareous marle mixed with Sand 39
Temperature 11° 7 Cent
Argillaceous Chalk 16
White Chalk 1365
Whitish Flints
Chalk with Flints
Fr. 1507
Temp. 23° 5 Cent
Grey Chalk
Fire Stone or Upper Green Sand 88
Temp. 26° 43 Cent
Gault Clay & Green Sand 182
1782 Fr

Boring Tools employed at Grenelle.

Fig. 1. Fig. 2. Fig. 3.

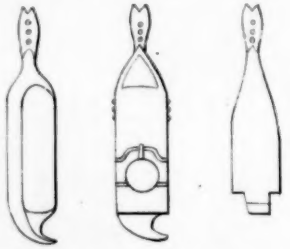
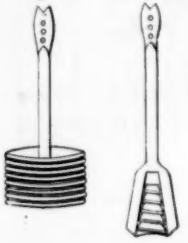


Fig. 4. Fig. 5.



IRON BATTERY FOR BLASTING.

Fig. 9

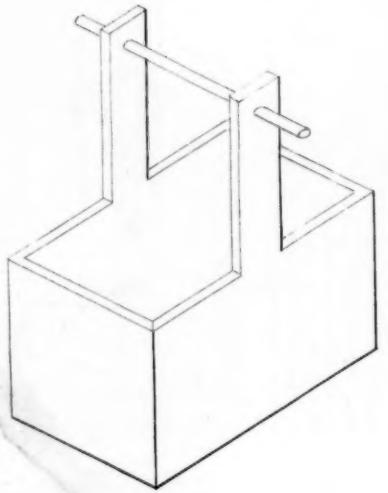


Fig. 7

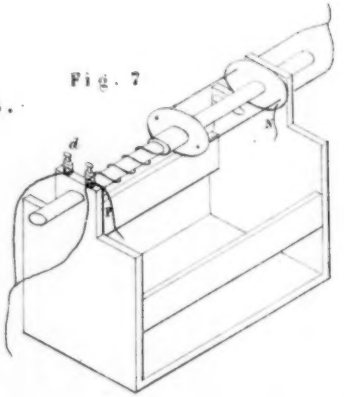
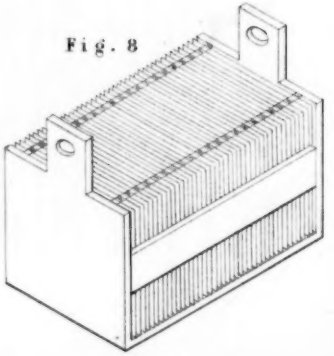


Fig. 8



Scale.

J. R. Jobbins, Lith.